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ABSTRACT

When resources are plentiful most enterprises flourish, including higher education, and the need for making difficult management decisions is not so pressing. In the late 1960's and early 1970's competing priorities for available resources, demographic forecasts of sharply declining enrollments among traditional college age populations, and public debate about the benefits of higher education have brought about an increased awareness that higher education institutions require effective management. Skepticism about employing quantitative management techniques to measure the essentially qualitative process of higher education has resulted in increased external pressures for better accountability methods. This has prompted higher educational institutions to try a variety of quantitative management approaches that draw on fields such as economics, mathematics, statistics, engineering, information science, and psychometrics. The higher education manager must continually seek to blend the universe of human values, preferences, aspirations, and interpersonal dynamics with the universe of things, facts, dollars, resources, and constraints. The educational research community must provide conceptual leadership in the development of appropriate measurement techniques or the void will be filled by those who have less understanding and support for education's intrinsic goals. (Editor)

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1977

Quantitative Approaches to Higher Education Management

G. Ben Lawrence and
Allan L. Service, Editors

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Foreword

When resources are plentiful most enterprises flourish, including higher education, and the need for making difficult management decisions is not so pressing. In the late 1960's and early 1970's competing priorities for available resources, demographic forecasts of sharply declining enrollments among traditional college age populations, and public debate about the benefits of higher education have brought about an increased awareness that higher education institutions require effective management. Skepticism about employing quantitative management techniques to measure the essentially qualitative process of higher education has resulted in increased external pressures for better accountability methods. This has prompted higher educational institutions to try a variety of quantitative management approaches that draw on fields such as economics, mathematics, statistics, engineering, information science, and psychometrics. These diverse fields can be tapped for a variety of steps or methods to deal with higher education management problems. These include analysis of "market" issues, measurement of outcomes and benefits, deployment of resource allocation, and analysis of educational productivity, among others. The authors stress that the higher education manager must continually seek to blend the universe of human values, preferences, aspirations, and interpersonal dynamics with the universe of things, facts, dollars, resources, and constraints. They warn that the educational research community must provide conceptual leadership in the development of appropriate measurement techniques or the void will be filled by those who have less understanding and support for education's intrinsic goals. G. Ben Lawrence is executive director of the National Center for Educational Management Systems (NCHEMS), and adjoint professor at the School of Education at University of Colorado, and was an associate director of WICHE. He also served as executive director of the National Commission on the Financing of Postsecondary Education. Allan L. Service is a senior staff associate at NCHEMS.

Peter P. Muirhead, Director
ERIC/Higher Education

Preface

The work that follows is an attempt to photograph the current status of the complex approaches and techniques that fall under the heading of quantitative approaches to higher education management. The field is broad and dynamic and we can only hope to have done justice to it here. One of the marks of progress is an atmosphere of change and growth, and so it is entirely possible that some aspects of the photograph we present at the time of writing will be faded or changed by the time of actual publication — or shortly thereafter.

This publication has been prepared by members of the staff of the National Center for Higher Education Management Systems (NCHEMS); however, the work described goes well beyond that underway at NCHEMS, and there should be no illusion that this monograph is in any sense an NCHEMS document or position paper. To the contrary, it is important to acknowledge our deep and serious debts to many others. The original researchers and practitioners who saw the potential for matching operations research and similar techniques to the management needs of higher education are the real founding fathers of the efforts described in this monograph. Over the years, many other participants have contributed to the progress described here. We are most familiar with those who have served NCHEMS in an advisory or policy-making capacity. Members of our Board of Directors, Technical Council, task forces, and other advisory groups have provided invaluable guidance and counsel to all of us who have been engaged in efforts to advance the state of knowledge. The work of those in the higher education research and development community is formidable, and much of it is referenced in what follows. The true measure of the work described here — and the source of our greatest debt — is the testing and use of quantitative information and approaches in higher education management practice.

Without the efforts of numerous planners, managers, and decision-makers in higher education institutions and agencies, much of what is related in this monograph would remain in the category of unfruitful exercises. The fact that we are able to describe realistically as much movement as we can is testimony to these practitioners who have actually used the approaches described in discharging their various responsibilities. Our point is simply that the work described here is due to numerous people. Many of them are named; many

others are not. To each of them we and the rest of the higher education community owe a real debt. The major contributors to this report are:

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Wayne R. Kirschling
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Overview

This research report is fundamentally an assessment of the current state of knowledge about quantitative approaches to higher education management. The expression "quantitative approaches" is subject to different interpretations. Attitudes about such approaches vary from strongly positive to strongly negative; some view quantitative techniques from a limited perspective while others think of these techniques as having global applications. One of the most significant points of this study is that there is no single approach, no one technique or model that fits all situations or circumstances; rather, the diversity and flexibility of higher education has given rise to a unique hybrid of techniques and approaches that vary in form and substance from one application to the next.

This report tries to capture the essence of these approaches, to delineate their capabilities as well as their limitations, and to provide some suggestions as to the prognosis for the future. It is divided into three parts: first is the context or setting that gave rise to quantitative approaches to higher education management; second is the substance of the work done to date as well as the problems and unmet needs that remain; and third is an assessment of the current and future impact of these approaches, which include signposts for further developmental work.

The first two chapters examine the context that prompted quantitative approaches to higher education management. The unique nature of the higher education environment is discussed with reference to the forces that created the need for improved management techniques. A parallel train of development concerns the origins and nature of operations research and the spread of related quantitative approaches through broader and deeper types of applications. Ultimately, the needs of higher education and the resource represented by quantitative management approaches mesh in the concept of quantitative approaches to higher education management. Some of the unusual features of management in higher education are highlighted. Decision-making, or the choice among competing alternatives, is viewed as the element that links quantification to the management environment. In this context, the roles and limitations of quantitative information usage are explored.

A consistent thread detailing both progress and limits of quantita-

tive approaches connects the next five chapters. There is a description of some of the foundations necessary for quantitative approaches; in particular, the notion of a common language — both definitions and procedures — is emphasized. Implications of information systems as a support to managers is discussed. Distinctions are made between operational data and management information, with suggestions given about how operational data systems can be made more supportive of management needs. Costs and outcomes, the two major bodies of quantitative information that characterize most of the management approaches, are described. Cost and resource information can be used in a variety of ways, including resource acquisition, resource allocation, budgeting, and resource management and control. In the area of outcomes the major steps are the identification of goals, the translation of goals into measurable objectives, and the development of quantitative information that can be used to assess outcomes and goal achievement. Formal mathematical decision models that fall within the more narrow definition of operations research and management science are reviewed. Major types of models are considered but more time is devoted to the age of discontent that seems to characterize reactions to formal models. This is especially pertinent, since models have been at the forefront of the quantitative movement; consequently, this discontent may well foreshadow reactions that will characterize other aspects of the management movement as it continues to develop.

The final three chapters focus on the challenge of the future. They encompass both an assessment of progress as well as provide some specific steps that need to be taken to facilitate the use of quantitative approaches in higher education management. There is a description of the extent of use that can be documented and some of the objective and subjective impacts of quantitative approaches are considered. Next there is a detailed look at the complexities inherent in understanding the types of impacts being studied, especially factors that influence use or nonuse of quantitative techniques. Indication of the type of work that needs to be done and a series of assessments concerning the major challenges facing those who advocate quantitative approaches to higher education management concludes the study.

The Need and The Resource

Education and management are among the oldest and most important human endeavors. Education — the sharing and transfer of knowledge and the development of new knowledge — has played a vital role in society throughout human history. In much the same way, management — the coordination, selection, and use of human and other resources to cause a desired result — has been a necessary part of human society's efforts. This concept of the permanence and centrality of both education and management is a vital part of the context for the developments and issues described in this study.

The focus here is on quantitative approaches to the management of institutions and agencies of higher education. The progress made in this sphere is discussed and the many needs that remain unmet and challenges for the future are described. The unique nature of higher education gives rise to numerous issues, limitations, and complexities that must be acknowledged, especially if they cannot be solved or eliminated. Certain implications are clear. Quantitative management approaches will not change the basic nature of the educational process, although perhaps they will enhance the capabilities of that process. Further, when viewed against the historical persistence of both education and management, quantitative approaches are brash newcomers, and expectations about their impact should be cautious. In sum, it is not our purpose here to claim or promise miracles from quantitative approaches to management in higher education but rather to present a realistic, careful appraisal of the current status of such approaches and suggest some indications of likely future directions.

It seems appropriate to ask, Why and where did quantitative approaches to management enter the higher education process? What were the stimuli for such developments and how did they come about? Responses to these questions usually take two forms: (1) there were factors within the higher education community that suggested a need for management improvements; (2) external developments gave impetus to the creation of a device that could contribute to such improvements. The interweaving of these two ideas comprises the essence of this report.

It is no secret that American higher education in the 1960s and 1970s encountered a series of unprecedented challenges, many of which remain unmet. The reports of the Carnegie Commission, the two-

volume *Higher Education: Toward an Uncertain Future,* published by the American Academy of Arts and Sciences (*Daedalus,* Fall 1974 and Winter 1975), and numerous others outline the breadth and scope of these challenges. For example, changing attitudes toward higher education among students, citizens, funders, and other constituencies forced a reexamination of many aspects of American higher education. Even such well-established and cherished concepts as the faculty tenure system came under fire. Demographic trends, especially among the traditional college-age population, prompted colleges and universities to face the fact of the end of the era of unlimited growth (Hodgkinson, NCHEMS *Proceedings of the 1976 National Assembly,* 1976). At the same time, the dual pressures of inflation and competition for financial resources meant that institutions had to confront at best steady-state or no-growth situations if not absolute shrinkages in the funds available. Also, pressures from governmental agencies and other funders for institutional accountability became more and more intense, with both institutional efficiency and effectiveness being questioned. New groups of potential students (e.g., the adult learner) were recognized at the same time that women, minorities, and others demanded equity.

The higher education community's response has been multidimensional and has used a wide variety of mechanisms. One aspect of the response was a heightened concern for the *management* of higher education institutions and agencies. As noted previously, management is not a new idea; institutional administrators have always planned programs, allocated physical and other resources, prepared budgets, enrolled students, paid salaries, and conducted a host of other activities that fall under the general rubric of management. But, relatively plentiful resources reduce the need for making truly difficult management choices. Furthermore, an inherent resistance to the notion of management from within the education community kept the task of managing higher education institutions in the background and deemphasized both its difficulty and importance.

The term "management" has not been extensively used to describe leadership and administrative functions within higher education; executives are still called administrators — a title given to individuals who provide operational direction and logistical support for carrying out policy directives formulated by a governing body. During the last two decades management became one aspect of higher education's response to change and challenge. An awareness developed that higher education institutions are complex, large-scale enterprises that require active management for full effectiveness. In essence, efforts by

higher education to respond to critics (both internal and external), to cope with economic forces, and to document both needs and effectiveness prompted a reconsideration of the academic world's traditional skepticism about the place of management at a college or university.

Today the term management is more and more accepted in higher education, although enthusiasm for its implications varies drastically. An increased concern with management implies to many a shift in emphasis from concern for people and scholarly efforts to preoccupation with numbers and cold-blooded efficiency. Such efforts are perceived by some in the academic world to be dehumanizing and a disservice to the tremendous task assigned to higher education by society. Nevertheless, there is evidently a significant body of opinion within the higher education community that sees more effective management of its institutions not only as compatible with the mission of higher education but also as a critical need if institutions are to survive and function effectively in the years to come. That perspective is reflected here. Management, especially quantitative management, is by no means dominant, but it is crucial to the responsibilities of institutions and agencies of higher education.

As higher education institutions attempted to improve their management, a variety of unmet needs became evident. Conscious *management* of aspects of higher education seemed a novel idea. Many if not most of those called on to act as managers felt some sense of compromise or conflict with their more traditional academic roles. In addition, there were significant gaps in the supporting resources needed by managers. Information to discharge management responsibilities was often entirely missing or of alarmingly suspect quality. Technological aids such as computers were available, but the most effective means of employing them in the management process were not at all evident. But perhaps most important of all, basic understanding of how the educational process functioned and how it could be influenced by management activities was very rudimentary.

One particular gap in management capability, which is the subject of this report, is the availability of reliable and appropriate quantitative information to support management, planning, and decision-making in institutions and agencies of higher education. Improvements were needed in the definition and collection of quantitative management information as well as in the techniques and processes for the use of such information.

The response to this need for enhanced quantitatively-oriented management capabilities emanated largely from a series of historical developments that had their genesis during World War II. It was at

that time that interdisciplinary teams of scientists — primarily mathematicians and physicists — applied their diverse skills and perspectives to solving a variety of complex problems. These groups worked on determining optimal location and search patterns for a system of radar stations in England, analyzing the timing and routing of invasion forces, balancing the cost of inventory shipping and storage against the cost of shortages and similar problems. These problems were addressed using scientific methods, mathematical models, quantitative analyses, and exploration of the effects of alternative courses of action. Because these early efforts focused scientific research on largely operational or logistical problems, the problem-solving techniques that evolved became known as "operations research" (Ackoff and Sasieni 1968).

After the war, theoretical and practical work in the same vein continued. A decade or more later, Dantzig (1963), Bellman (1957), and others advanced the sophistication and complexity of the mathematical models available to operations research analysts. At the same time it became apparent that these new problem-solving approaches had considerable application in industry. Operational problems, such as control of inventory levels, allocation of inventory levels, allocation of physical resources, and sequencing of activities were subjected to the operations research approach. These problems had in common a relatively high degree of structure, an identifiable set of decision alternatives, a measure of overall performance to assess the decisions made, and a susceptibility to quantitative description. By the early 1960s a substantial body of theory and practice had emerged and was continuing to grow. Wagner (1969) provides perhaps the best compendium of the sum and substance of this work.

The field continued to grow along several dimensions that brought it closer to application to the higher education management needs described above. Potential for using analytic approaches in areas beyond operational and logistical problems was recognized. Areas such as organizational analysis, long-range planning, and overall resource allocation were seen as larger scale applications that promised even bigger payoffs than the analysis of operational and logistical problems. At the same time, new complexities were introduced — including the need to incorporate outcome and benefit considerations, the necessity to describe complex interrelationships between and among different parts of the system being studied, and the difficulties associated with understanding the human and political factors surrounding decisions in these areas. In contrast to earlier applications, the problems encountered were often ill-structured or messy, the alternatives available

were not always clear or easy to generate, the performance measures only implicit or incompletely specified, and the difficulties of quantifying key variables often formidable and occasionally insurmountable. As we shall see later, all of these problems are characteristic of attempts to use quantitative management approaches in higher education.

In developing the new concepts and methodologies needed to cope with these kind of challenges, operations research continued to rely heavily upon and integrate the work of many different quantitative disciplines. Economics, mathematics, statistics, engineering, information science, psychometrics, and others now play a role in providing systematic and quantitative approaches to management. In fact, the field has grown sufficiently broad that the designation operations research is now only one of several in common use. Other labels — such as management science, policy sciences, and system analysis — are equally current. Distinctions among these fields can be made but such differentiation is not critical to our purposes here. We are focusing on quantitative approaches to management generally and on their interface with the unique needs and characteristics of higher education institutions and agencies. The labels applied to specific techniques or groups of techniques are much less important than their relevance and utility to higher education.

Perhaps the most critical dimension of growth was the expansion of applications beyond the military and industrial sectors and into the governmental and human service arenas. Early applications were once again heavily oriented toward operational problems. Edie's analysis (1954) of waiting lines at bridge and tunnel toll booths is a classic example. Other work focused on problems such as scheduling of hospital bed usage, ambulance routing, traffic scheduling, and interstate highway route planning. Areas of application included local, state, and federal government operations; hospital operations and health systems planning; land use modeling; housing supply and demand; and a host of others.

As was the case with military and industrial applications, quantitative approaches to policy began to emerge. Systematic and quantitative planning methodologies were used for systems of social welfare agencies (Mantel et al. 1975), federal government agencies (Novick 1975), and other major sectors of government and the human services. New methodologies such as cost-effectiveness analysis and Planning, Programming, Budgeting Systems (PPBS) were developed to meet new applications. Some of the progress and many of the difficulties and issues have been chronicled by Morse and Bacon (1967), Drake et al. (1972), Blumstein et al. (1970), Hoos (1972), and Quade (1975).

The potential represented by quantitative approaches to management problems and the management needs of higher education traveled parallel courses for almost two decades. The need and the resource began to some together in the late 1960s. At first this was largely through isolated efforts at a small number of institutions. Studies were made, for example, at Purdue on student scheduling (Abell et al. 1965); at Tulane on computer-assisted menu planning in university hospitals (Blackburn and Balintfy 1967); at the University of Illinois on a systems approach to campus parking (Narragan 1970); and on analytical planning and cost accounting for university libraries (Leimkuhler and Cooper 1970). Other institutions developed problem-solving approaches based on operations research concepts and techniques in such areas as cash and endowment management, purchasing and inventory control, preventive maintenance and physical-plant work scheduling, and replacement of large-scale equipment.

Given the needs of higher education and the developmental history of quantitative management approaches in other sectors, it is not surprising that application of these approaches in colleges and universities moved toward problems of planning, policy formulation, and resource allocation. Operational and logistical problems received less attention. In addition, colleges and universities began to spend their analytical energies in responding to external constituencies (e.g., state and federal agencies) and issues (e.g., financing, student response to tuition increases) as opposed to internal efficiencies. The net effect was an attempt to apply quantitative approaches to a wide variety of policy and decision-making areas, including but not limited to:

Analysis of "Market" Issues

Many complex policy issues in higher education deal with pricing, supply-and-demand, and the market forces within and around the enterprise. For example, student assistance programs, tuition charges, and internal pricing or chargeback systems (e.g., computing services) all raise market-related issues and have been the object of analytical attention within institutions and at state and federal levels.

Measuring the Outcomes and Benefits of Higher Education

The outcomes of higher education range from student gains in knowledge to education's contribution to national economic growth. A wide range of approaches have been used to measure and understand these outcomes. Psychometricians have concentrated on problems such as measuring student attainment and its relation to the college environment, while economists have focused their efforts in

areas such as measuring the return on investment in higher education. This return is described in terms of effects on human capital or contributions to overall economic growth. Other analysts and scholars are attempting to advance understanding of other individual and societal results that are attributable to higher education. It must be said, however, that quantitative approaches in the outcomes area are presently more severely circumscribed in their application than those focused on any other aspect of higher education.

Resource Allocation

Colleges and universities reflect their resource allocation decisions in a variety of ways — in annual budgets, by adding new programs, and by cutting back others. These resource allocations are the result of an analysis of alternatives and a complex array of implicit and explicit tradeoffs. In the development of quantitative aids considerable attention has been given to testing the ramifications of these tradeoffs and thereby to improving both the effectiveness and efficiency associated with particular resource-allocation decisions.

Analysis of Educational Productivity

Understanding of educational productivity is another area in which lack of a commonly accepted definition and adequate quantitative methodology have proven especially frustrating and challenging. Productivity, defined as the value of outputs relative to the value of inputs, premeates many of the decisions that planners and managers make. The concept includes many different dimensions and issues (Wallhaus 1975) and affects a wide variety of people in higher education. The economic model of the "firm" provides some theoretical basis for understanding educational productivity, but this is not a completely satisfying analogy. The social and behavioral sciences, in particular, will be required to make increasingly larger contributions in the future to increase understanding of issues such as individual or organizational incentives and constraints (Kirschling and Staaf 1975).

Measuring the Use of Resources

Colleges and universities have become the object of increased scrutiny by external agencies and face continuing pressures for improved accountability. The response necessary is development of better measures and means of analyzing the use of resources — workload analysis, unit costs, student loads induced on academic departments, etc. The analytic methodologies that are still evolving are

based largely on the principles of cost accounting and various industrial engineering techniques.

Although these illustrations are by no means comprehensive, they should serve to reinforce several ideas that must permeate the discussion of quantitative approaches to higher education management. One key point is that there is *no single approach*. Rather, the field has evolved into a complicated amalgam of different concepts and methodologies drawn from a diverse set of quantitatively oriented disciplines. It is in this sense that the quantitative approach can be viewed as a resource — a set of possibilities — rather than a direct answer or solution to any of the problems and opportunities confronting higher education today. The extent to which the resource matches or can be tailored to meet the need will govern its ultimate utility.

It should also be obvious from the foregoing discussion that this process of matching is not an easy matter. Simplistic claims and overstatement of possibilities will do more harm than good. It will be much more productive in the long run to face problems and issues squarely, to deal with them as effectively as possible, and to admit openly when they are not yet (or cannot be!) solved. It does not destroy the potential merit of quantitative management approaches to admit, for example, that there are certain parts of the higher education process that will probably defy quantification. Nor should recognition of the complex nature of higher education's governance and political structures deter those seriously interested in improving management through quantitative approaches. These and other unique characteristics of higher education — and there are many — ought rather to be the guiding force that shapes the continued development of the emerging young hybrid that is described here under the mantle of quantitative approaches to higher education management.

The remainder of this monograph will provide one view of the substance of this hybrid, the *progress* that has been made, the *limitations* that now remain and may continue to remain, and the *challenges* inherent in the future. The following chapter examines more closely the nature of management and decision-making in higher education. This consideration includes a view of some of the conceptual and operational issues that surround the use of quantitative information and techniques in that context.

Management, Decisionmaking, and Quantification

One of the most fundamental misconceptions about the application of quantitative and systematic approaches to higher education management is the persistent impression that the purpose of these approaches is to *solve problems* for management or to *make decisions* outright. This is not the case, behavior of some analysts and administrators notwithstanding! Management, especially management of higher education, is simply too complex a task to be reduced to a set of routinized numerical procedures. Because this point is so critical to an appreciation of the proper role of quantitative approaches, it merits examination at some length. Accordingly, this chapter reviews the management environment that characterizes higher education, delineates the nature of the decision-making task within that environment, and describes some of the major implications and limitations that arise with respect to the use of quantitative management information and techniques.

The most basic characteristic of the management environment in higher education is, of course, the relationship of management to the nature of the educational process itself. The core of that process is the interaction between a learner and some source of knowledge — a book, a teacher, nature itself. These interactions potentially exhibit all of the complexity of most human interactions. The critical mass of these individual interactions becomes formidable indeed when compounded across types of students, fields of study, student and faculty preferences, methods of inquiry, and a host of other factors. Thus, the typical higher education institution is a tremendously dynamic and complex place. This situation has two implications for the manager and for quantitative approaches to management. First, the manager must never lose sight of the fact that management is only a means to an end — an important means, to be sure, but still only a means. Learning is the goal. Management and management techniques that directly or indirectly permit more effective learning or broadened opportunities for learning can be viewed positively. Those that do not support learning should be viewed with suspicion if not rancor. In a very real sense, the manager in an institution of higher learning must continually synthesize a plan of action from two aspects of reality: (1) a world of people, human values, preferences, aspirations, and interpersonal dynamics and (2) a world of things, facts, dollars, resources,

and constraints. The creativity of this synthesis is the fundamental measure of a higher education manager's effectiveness.

A second observation that arises from considering the nature of education is that colleges and universities *are* complex organizations and as such require active rather than passive attention to their management. As Brown and Luedeke (1975) put it: "an external definition of comparative simplicity seems to have penetrated the campus" (p. 576). They argue persuasively for a more realistic view:

> If one were to compare the alternative ways among institutions of higher learning of delivering a baccalaureate degree in history along with the myriad of services supporting that delivery to the alternative ways of delivering a new automobile, one might well conclude that institutions of higher learning comprehend a higher degree of complexity in terms of audience, "options," and other features (pp. 575-6).

Managing in the midst of this complexity and in a manner that supports and enhances both complexity and diversity is a truly challenging task. Quantitative approaches are only one of many supports needed by the higher education manager! Other characteristics of the higher education management environment arise from the ways in which colleges and universities are organized and operated. Czajkowski (1973) and Bacchetti (1977), among others, have pointed out some of these factors.

For one thing, colleges and universities are usually highly decentralized. This results in many little suborganizations or "businesses," each with considerable diversity and autonomy — particularly with regard to logistics and operations. The application of quantitative management techniques to relatively small-scale problems is likely to result in substantially less payoff than in the case when large or "bread and butter" problems are the focus. Higher education ought not to expect very many of the situations found in industry (e.g., mathematical programming solutions to blending problems in the petrochemical industries) in which even slight improvement justifies the cost of analysis many times over. Marginal or incremental improvements are much more likely to be the norm in higher education.

Support functions in colleges and universities (e.g., purchasing, physical plant, student registration and scheduling) are, as the term "support" implies, usually viewed as of secondary importance to the primary programs of instruction, research, and public service. High-level administrators must give priority attention to the external environment and constituencies (i.e., legislators, alumni, students, state agencies) and place more importance on analytical studies directed to-

ward costs and outcomes of primary programs, improvement of productivity, and budgeting and finance, as opposed to analytical studies directed toward internal efficiencies. This attention appears necessary even though support functions account for between 40 and 50 percent of total expenditures in most institutions.

Real incentives to cut costs in colleges and universities are often lacking for a variety of reasons. Dollar savings may in effect revert to the state treasury rather than being "freed up" for reallocation to other programs or institutional purposes. Implementing cost-saving techniques may jeopardize the operating philosophy or even the survival of an organizational unit. Further, it is often difficult to measure the overall impact of a new procedure or operating efficiency, so it is usually impossible to institute meaningful reward systems.

Finally, one other characteristic of the management environment and attitude toward quantitative techniques must be recognized even though it is not especially pleasant. There is a certain inherent resistance to quantitative approaches that arises from the impression that such approaches are oriented only toward *things* and pay no attention to *people*. In the higher education environment, oriented so thoroughly to people and human values, this impression leads to a suspicion of quantitative approaches and a reluctance to believe they can contribute positively. It must also be said that early proponents often strengthened rather than weakened this impression. Overenthusiasm, an apparent lack of adequate attention to human values and issues, and frequent oversimplification of the difficulties and complexities involved did little to raise levels of appreciation or confidence among managers. Capabilities were often oversold and results many times fell short of expectations. Because of unfamiliarity with the quantitative methodology being employed, higher education administrators viewed the results with scepticism, and the insights gained were often ignored or misunderstood. The financial and human resources required to implement quantitative approaches were often seriously underestimated. Applications were often pursued in isolation from the "big picture," and crucial factors such as wide-scale understanding and acceptance, the political environment, and the potential negative effects on other organizational units and programs were frequently overlooked. The net result of these and other miscues has been to make progress and acceptance of quantitative techniques even more difficult in an environment already challenging the desirability of the approach.

In summary, the higher education management environment derives its unique and challenging nature from a wide variety of factors: the

nature of the educational process and the necessarily subordinate role of management, the complexity of individual colleges and universities, decentralization, emphasis on primary programs, lack of efficiency incentives, and a degree of mistrust or suspicion of quantitative approaches to management. Given the nature of the environment and the nature of the management function, it becomes important to ask: Where and how do quantitative approaches fit it? The linkage is to be found in the *decisions* that all higher education managers face.

A decision means making a choice among a set of competing alternatives on the basis of some criterion or assessment mechanism. The alternatives in question may be different programs, various budget configurations, or other possibilities for resource utilization. The key issue is the fact that personnel, dollars, time, and other resources are always limited, and the decision to accept one alternative implies a parallel choice to reject one or more other alternatives. The assessment mechanism used to make these choices may be explicit or implicit, formal or informal, quantitative or qualitative. All of this is influenced by individual values and preferences, history, environment, and the substance of the decision under consideration.

Once the focus on decision-making within management emerges, the major role of quantitative information and techniques becomes more clear. Quantitative approaches can help to identify and illuminate the alternatives available to the decision-maker. Enriching the alternatives considered enhances the likelihood of a "good" decision; i.e., one that yields the desired consequences. As Quade (1975) puts it:

> If the alternatives are all good, the decision will be a good one—perhaps not the best, but still good. If some of the alternatives are poor, the issue may still be in doubt (p. 123).

It is worthwhile noting that enhancing a manager's ability to make *better* decisions does not at all imply that such decisions will be *easier*. Indeed, knowing more about alternatives and their consequences may well make the manager's life more difficult. Increased complexity of choice, greater visibility of the elements used in reaching a decision, and enhanced likelihood of accountability are just some of the factors that appear to go along with more effective decision-making. Also, it must be recognized that state-of-the-art limitations on abilities to provide quantitative information imply that today's manager must be careful and selective in relying on such information.

In examining specifically how quantitative approaches are to be integrated with the decision-making process, it is useful to consider

Schmidtlein's (1971) two extreme paradigms of that process. At one extreme is the *incremental/remedial* approach characteristically taken by the intuitive, political decision-maker. The incremental/remedial process emphasizes the difficulty in specifying concrete goals and objectives, in explicitly separating means from ends, and in formally resolving conflicts about values. Its underlying premise is that political and social forces, if allowed to take their course, will produce the best possible solution at any given point. Consequently, the incremental/remedial decision-making approach seeks to gain consensus regarding the relatively small, incremental step to be taken next. The step may be designed to remedy a perceived deficiency or capitalize upon a perceived opportunity. With each such step, the decision-maker hopes to gain insight into how future improvements can be made through relatively minor adjustments — the so-called remedial process. Thus the incremental/remedial decision-making approach is designed to achieve a sequence of politically viable improvements over time.

At the other extreme, Schmidtlein describes the *comprehensive/prescriptive* paradigm. This decision-making process is characterized by its extensive use of recent developments in systematic planning and management concepts such as Planning, Programming, and Budgeting Systems (PPBS). This approach assumes that a comprehensive list of objectives can be determined in advance, that cause-and-effect relationships can be explicitly defined, and that value systems can be systematically and rationally incorporated into the overall decision-making process. The comprehensive/prescriptive method is to attack the problem with a single grand design that spells out where we are going and who does what — in advance of taking a large step with long-range consequences.

Neither of these paradigms is ever used in its pure form. Virtually all planning and management practices fall somewhere on a continuum between the two extremes. The trick is to discover which elements of each approach should be blended together into an overall planning and management process that is appropriate for the problem, the environment, the time-frame, and the relevant constraints. Some factors, such as the extensive interrelationships that characterize higher education and the need for long-run, broad-based solutions to problems, press managers toward the comprehensive/prescriptive approach. Other elements, including the political and value-laden nature of the educational decision-making process and the tight time constraints that are often operative, tend to favor use of the incremental/remedial approach.

The fundamental lesson here for the analyst or manager interested

in quantitative approaches is that every decision-making situation is likely to exhibit a compound mixture of both paradigms. Thus, users of quantitative information and techniques must be sensitive to the character and implications of both approaches. Attempting to support a comprehensive/prescriptive approach in a situation that is heavily incremental/remedial (or vice versa) is virtually certain to lead to frustration at best and total failure at worst.

The manager operating in an incremental/remedial mode is likely to gather information in a random, experiential manner and not worry too much about its sophistication. He or she will rely heavily on values, interpretation of past experiences, and intuition. Information, quantitative and otherwise, that is most readily available is likely to have greatest impact. On the other hand, the manager who prefers the comprehensive/prescriptive paradigm feels that by taking all known facts into account, a sounder course of action will emerge. His or her attitude toward really systematic collection and use of quantitative information is thus likely to be much more positive. In either case, the quantitative approach must be carefully circumscribed and tailored to the particular situation in focus.

All of this discussion of the context for quantitative approaches to higher education management is intended to convey a tone of realism, but not pessimism. The higher education process *is* unique and dynamic. Quantitative approaches to management *are* relatively recent developments and are very far from full maturity. The higher education management environment *does* exhibit a variety of unique and challenging characteristics. And the decision-making process that is the most direct target of quantitative approaches *is* composed of complicated and even conflicting elements. Nevertheless, some progress *has* been made. The substance of this work to date is the subject of the next section.

Foundations for Quantitative Information

The higher education manager who seeks to apply any quantitative approach must immediately address two basic questions: (1) What information is needed? (2) How can that information be obtained? Whether they are encountered explicitly or only implicitly, these two questions continue to pervade all aspects of quantitative approaches to higher education management. Specific answers, i.e., individual pieces of information or particular sources and procedures, must await delineation of the decision-making context and needs. However, it is possible to make certain generic observations about the foundations needed for quantitative management information and techniques.

The paramount need encountered is for a *language* that can adequately describe higher education institutions, agencies, and programs. Such a language is important in two respects. First, it provides the basic vocabulary to be used in talking about higher education and its management. The words of the language are the building blocks waiting to be assembled into a pattern that illuminates decision alternatives or in some other way supports management. Second, language is the source of the grammar that guides or structures the manner in which individual words are related to each other to yield complete thoughts. The words of English or any other language can be combined in myriad ways, depending upon the intent and skill of the language user. So, too, pieces of information can be combined in a variety of ways depending on the needs and constraints that characterize a particular decision-making environment. The function of grammar is to ensure that there is some consistency in the way words are strung together and at the same time to maintain the integrity of the meaning of individual words (i.e., pieces of information).

Those attempting to develop a quantitative language for higher education managers have encountered many of the same issues and difficulties that are inherent in other languages. For one thing, words have meaning only insofar as common usage ascribes that meaning to them. Thus the word "ground" describes the earth below us because we have agreed that it does and not because there is anything intrinsic to the word or the earth that makes it so. Similarly, the term "full-time equivalent student" can potentially mean whatever

we or others decide that it means. The need to ascribe meanings to words does not cause any difficulty *unless we do not agree upon the meanings*. If different individuals use a superficially identical language in different ways, miscommunication and its consequences are the inevitable result. Thus, if one institutional manager (e.g., the registrar) defines a full-time equivalent student in one way and another manager (e.g., an academic dean) uses the term differently, communication between them will be in some way hampered. These two managers will not even agree on the number of students in attendance at their institution! The lesson here is that considerable attention must be paid to developing consistent meanings for the elements of the higher education management language. Without such consistency, prospects for long-term positive impacts through quantitative approaches would appear minimal.

Earliest efforts to standardize and make explicit a quantitative language for higher education managers focused on ways of describing particular categories of resources. Standardized definitions, categories, and data collection procedures were developed for facilities by Dahnke et al. (1971) and Romney (1972) and for personnel by Minter (1972) and Jones and Drews (1977). The results of this work, carried out by the National Center for Higher Education Management Systems (NCHEMS), under contract to the National Center for Education Statistics (NCES), have since been incorporated in the Higher Education General Information Survey (HEGIS) conducted by NCES. Given the nature of the task, it is not surprising that it is characterized as much or more by attempts to obtain consensus for workable compromises as by efforts to obtain a single "correct" answer.

Similar work in the area of financial measures and definitions provides an especially clear illustration of this last point. The consensus-building effort was carried out through a vehicle called the Joint Accounting Group. The group included representatives of the American Institute of Certified Public Accountants (AICPA), the National Association of College and University Business Officers (NACUBO), and NCHEMS. One objective of the effort was refinement and standardization of certain parts of the financial language (e.g., revenue and expenditure categories). Once this was accomplished, the results were described in *Report of the Joint Accounting Group* (1974). More importantly, however, all three organizations agreed to use these common financial measures and definitions and to recommend them to their constituents. Thus, the substance of the Joint Accounting Group's work is now reflected in AICPA's *Audits of Colleges and*

Universities (1973), NACUBO's *College and University Business Administration* (1973), and NCHEMS's *Higher Education Finance Manual* (Collier 1975). In short, an important part of the necessary costing language for management has been made explicit and standardized sufficiently to serve as a sound basis for communication.

Many other parts of the necessary language foundation still remain incomplete. For example, ongoing work in the areas of cost and outcomes information (see Chapters V and VI) suggests the existence of numerous unresolved definitional and procedural issues. Some ideal of the full scope of the language that is emerging can be obtained through reference to the NCHEMS *Data Flement Dictionary* (Goddard et al. 1973) or similar documents developed for individual campuses. Furthermore, the emergent perspective that views higher education as embedded within postsecondary education (PSE) suggests that even more fundamental work is still ahead. As a recent report of joint efforts of the Coalition of Adult Education Organizations and NCHEMS (Collier and Roberts 1976) puts it:

> The current PSE language tends to limit the user's thinking about postsecondary education, its purposes, and its constituencies. . . . The current language of educational planning and management is not only restrictive and often times pejorative, it also reinforces the idea that PSE is a series of uni-dimensional compartments. Therefore, a new language for PSE should incorporate and reinforce the multi-dimensional framework for conceptualizing and viewing PSE. It should also serve to focus the attention of planners and managers upon the important planning parameters and it should allow them to *expand* their thinking about the who's, why's, how's and for whom's of PSE rather than restricting that thinking (p. 5).

That same report goes on to suggest a framework for viewing PSE and a language for describing PSE programs. However, it is clear that work in this area is still far from complete.

In parallel with efforts to define and refine the *words* of the higher education management language, other work has focused on the *grammar* or structure of that language. This structuring has two dimensions: (1) delineation of the program entities about which quantitative information is needed and (2) the internal organization and interrelationship of various bodies of quantitative information.

This first dimension was the target of some of the earliest work carried out by NCHEMS. The result was the NCHEMS *Program Classification Structure* (Gulko 1972). The Program Classification Structure (PCS) is "a framework that allows for the classification of a postsecondary education institution's resources and programs/activities in accordance with their relationship to the accomplishment

of institutional objectives." It was developed to allow planners and managers in colleges and universities to relate such information to the programs institutions carry out to achieve their objectives. Specifically, the PCS is a logical framework that allows an institution to array information in a hierarchical disaggregation of programs, in which a "program" is defined as an aggregation of activities serving a common set of objectives. There are eight major categories called "programs" at the highest level of aggregation in the PCS, each of which can be further disaggregated into subprograms. The eight "programs" in the PCS are the following:

- 1.0 Instruction
- 2.0 Research
- 3.0 Public Service
- 4.0 Academic Support
- 5.0 Student Services
- 6.0 Institutional Support
- 7.0 Independent Operations
- 8.0 Student Access

These eight "program categories" do not represent institutional objectives; rather they are a prototype list of the "programs" that an institution would undertake in order to attain its objectives. The PCS program categories may or may not correlate with a particular institution's organizational structure, depending upon how closely organizational units correspond to objective-oriented programs.

In an attempt to keep pace with the changing needs of higher education as well as reflect the broader perspective of postsecondary education, NCHEMS has recently reissued the PCS in revised form (Collier 1977). Particular attention has been paid to refining the definition of the instructional program and to expanding the set of subprograms within that program. The current version of the PCS is shown in Figure 1. The elements of the PCS can serve as common denominators for bringing together a wide variety of different types of information. Each type of data—personnel, costs, outcomes, etc.—can be linked in the same way to particular PCS categories. The ultimate result of this kind of linkage should be a comprehensive quantitative profile of those categories, i.e., programs. At the very least, this kind of exercise should reveal continuing gaps in the quantitative management language. There are several other reasons why this strategy is important.

Program Planning, Budgeting, and Evaluation—One of the most important reasons why a program-oriented structure is important for quantitative data formatting is that it can support program planning, program budgeting, and program evaluation. Program-oriented management assumes increasing import as managers focus their attention on the achievement of specific objectives and on the definition of programs to achieve those objectives. Program-oriented management aids decision-makers in looking at the objectives educational activities are intended to achieve and in evaluating whether or not (and how well) those objectives are being achieved. Particularly when limited resources must be managed it is important to ask, "What do we intend to accomplish with our dollars and how well did we accomplish it?" The PCS, as the most widely used program-oriented structure, has proven to be a popular and effective prototype, or starting point, for institutions seeking to develop program planning and management systems.

Common Denominator for Different Data—A second reason why a program-oriented structure is valuable is that it can be used in support of analysis involving different types of data. Many structures are designed to fit the unique characteristics of one type of data and are, therefore, ill-suited to the association of one type of data with another. However, the PCS, by focusing on programs, is able to accommodate many different types of institutional data. Meaningful analysis necessitates the coordinated review and assessment of many different types of data. For example, an assessment of the need for faculty necessitates an analysis of personnel data, financial data, faculty workload data, and so forth. To do this, the data must have some common denominator. The PCS is such a denominator.

Link of External Data—A third strength of program-oriented structures is as a link between the institution's own data and data external to the institution. The ability to link one's own data to that of others gives the manager the capability to employ comparative analysis as a tool for decision-making. Interinstitutional comparative analysis has proven to be an effective aid in understanding how other institutions utilize resources to accomplish "similar" objectives.

There are several reasons why the PCS, in particular, has become the most widely used program-oriented structure for the exchange and reporting of institutional data. One of the primary reasons is that the PCS is the only generally available structure that is both well-defined and relevant for multiple types of data. In addition, it includes a comprehensive and consistent set of definitions and data classification procedures that help to assure that the data from all

Figure 1. Revised Program Classification Structure

PSE Organizational Entity

1.0 Instruction	2.0 Research	3.0 Public Service	4.0 Academic Support
1.1 General Academic Instruction (Degree-related)	2.1 Institutes and Research Centers	3.1 Direct Patient Care	4.1 Library Services
1.2 Professional Career Instruction (Degree-related)	2.2 Individual or Project Research	3.2 Health Care Supportive Services	4.2 Museums and Galleries
1.3 Vocational/Technical Instruction (Degree-related)		3.3 Community Services	4.3 Educational Media Services
1.4 Requisite Preparatory/ Remedial Instruction		3.4 Cooperative Extension Services	4.4 Academic Computing Support
1.5 General Studies (Nondegree)		3.5 Public Broadcasting Services	4.5 Ancillary Support
1.6 Occupation-related Instruction (Nondegree)			4.6 Academic Administration
1.7 Social Roles/Interaction Instruction (Nondegree)			4.7 Course and Curriculum Development
1.8 Home and Family Life Instruction (Nondegree)			4.8 Academic Personnel Development
1.9 Personal Interest and Leisure Instruction (Nondegree)			

PSE Organizational Entity

5.0 Student Service	6.0 Institutional Support	7.0 Independent Operations	8.0 Student Access
5.1 Student Service Administration	6.1 Executive Management	7.1 Independent Operations/ Institutional	8.1 Student Recruitment and Admissions
5.2 Social and Cultural Development	6.2 Financial Management and Operations	7.2 Independent Operations/ External Agencies	8.2 Financial Aid Administration
5.3 Counseling and Career Guidance	6.3 General Administration and Logistical Service		8.3 Scholarships
5.4 Student Health/Medical Services	6.4 Administrative Computing Support		8.4 Fellowships
5.5 Student Auxiliary Services	6.5 Physical Plant Operations		
5.6 Intercollegiate Athletics	6.6 Faculty and Staff Auxiliary Services		
	6.7 Public Relations/ Development		
	6.8 Student Records		

Source: Collier 1977

institutions are consistently formatted. Finally, a program format is an effective means of assuring reasonable commonality among a diverse set of educational institutions. Looking at data structured in terms of *what the institution is attempting to accomplish* allows one to avoid many of the problems encountered when using another organizing framework (e.g., organizational structure).

Further work remains to be accomplished in the area of structure for higher education's management language. Some of this is already underway. For example, the National Center for Education Statistics (NCES) is currently sponsoring the development of a new *Taxonomy for Subject Matter*. This taxonomy is intended to be used across the full scope of education. Similarly, NCES recently funded a major project whose objective is the development and implementation of standardized terminology for the adult and continuing education field. Efforts to structure the information categories themselves are also evident. Cooperative efforts between NCHEMS and the Federal Interagency Committee on Education (FICE) to develop a standard set of terminology about sponsors and providers of education provide one example. Lenning et al. (1977) describe another in the area of outcomes information.

Before concluding this chapter, one final type of structural foundation must be mentioned. In generic terms, this particular technique involves the linking of one information or program structure with another through some item of information relevant to both structures. By far the best known example is the *academic matrix* concept originally conceived by Suslow and since popularized by others in the form of the induced course load matrix or instructional work load matrix (Suslow 1976). The generic matrix takes various specific forms. In Suslow's words:

> The most common form is a matrix of coefficients expressing ratios of course credits per student for academic areas. For example, a coefficient of this type of matrix might express the average number of course credits taken in undergraduate courses of anthropology by students whose major field of study is economics. Other types of matrices have coefficients expressing such ratios as the average number of course enrollments or class hours in every academic area per student in every academic major (pp. 35-36).

The linking of one structure (e.g., academic disciplines) with another (e.g., student majors) through a common measure (e.g., student credit hours) permits some understanding of interrelationships that may be quite critical to management and decision-making. This type of matrix has been found to be useful in its own right (see, for example

Graves 1975; Patterson and Minahan 1977; Huff and Young 1974) as well as in an intermediate role within higher education cost simulation models (Clark et al. 1973). It is not unreasonable to suppose that more of this type of structure-to-structure relationship will emerge as the higher education management language evolves over time.

As noted earlier, a standardized and consistent quantitative language—both vocabulary and grammar—is absolutely essential to the longer term effectiveness of the management approaches described in this monograph. Such a language should not be a rigid and constraining force. Rather, it should represent a rich and diverse resource that the higher education manager can draw upon in discharging his or her responsibilities. The resource is by no means fully developed, but some significant progress has undeniably occurred, and increasing momentum is evident in its utilization.

Information Systems in Support of Management

One idea that should have become increasingly obvious during the course of this study is that the energy required for utilizing effective quantitative approaches to higher education management is potentially quite large. The complexity of the educational process and decision-making environment combines with the considerable volume of data actually or potentially available to create a formidable challenge. In response, the quantitatively oriented manager seeks to take advantage of any and all supports that are available. Some of the most visible and effective of these supports come under the heading of *information systems,* both manual and computerized.

In examining the role of information systems as a support for quantitative approaches, it is helpful to make an immediate distinction between data and information. In Balderston's (1974) words:

> Raw data—individual entries in the ledger, lists of names in a file cabinet, notes in an envelope in the president's coat pocket, or a record that Andrew Green got a B- in English 103 in the fall quarter—scarcely qualify as information. Information is a set of elements needed for a current or future decision. Raw data always need to be aggregated, transformed, interpreted, and appropriately conveyed to serve as information for a decision (pp. 230-231).

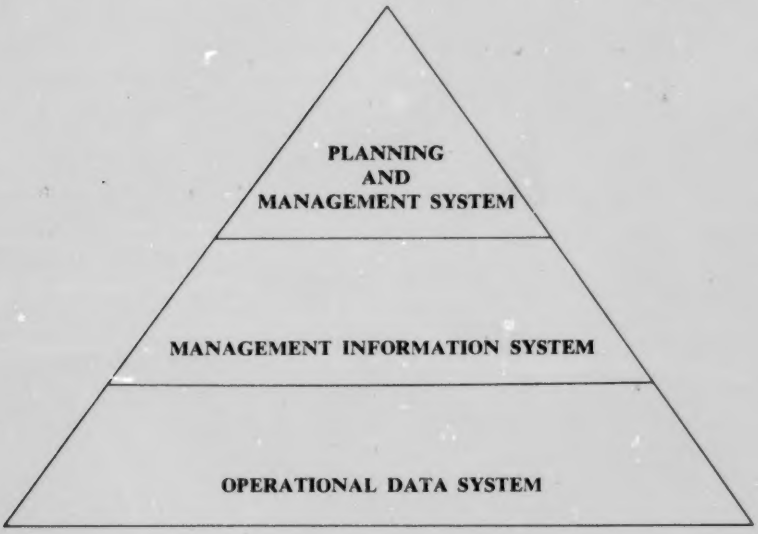
This transformation of data into information — often called analysis — is a particularly crucial determinant of the effectiveness of the quantitative approach in a specific decision-making context. An appropriate and insightful transformation enhances the likelihood that the manager will actually use the result rather than simply add it to a possibly large collection of already existing data. However, even good information is not enough. It has been noted that:

> . . . the simple existence of information does not automatically produce knowledge or understanding. In other words, truly effective use of information comes about when the manager or planner can learn something that contributes to understanding of future activities and decisions. Indeed, one of the major contributions of data and information may be to add in a general way to the manager's overall understanding of the institution and its programs (Service 1975, p. 142).

This data/information/understanding spectrum has some parallels in the several levels of information systems that characterize most institutions. The most basic category is a set of *operational systems*

that provide direct support for the administrative functions necessary to operate an institution (e.g., payroll, accounting, student records). Whether computerized or not, these systems must exist in some form at literally every college or university. These systems can be thought of as the base of a pyramid (see Figure 2 and Sheehan 1972) and provide the basic raw material from which information and understanding must be extracted.

Figure 2. Information Systems Hierarchy



Source: Sheehan 1972

The next level of system, frequently referred to as the *management information system,* builds upon the basic operational level. It integrates and transforms operational data into information needed to monitor, control, and analyze on-going operations. Finally, the systems hierarchy is completed by a third level, sometimes called a *planning system,* that uses aggregated management information to support consideration and formulation of institutional policies and plans and provide better understanding of possible future directions and decision alternatives.

It should be noted that some authors use the term "management information system" to refer to relatively sophisticated data entry, storage, manipulation and retrieval systems (e.g., integrated files, access methods, etc.) encompassing all three levels of information systems described here. Throughout this monograph, "management information system" is used only as a level of information need and not as a measure of technology. Being aware of this distinction and the existence of divergent meanings for "management information systems" may be useful in avoiding misunderstanding in other contexts.

Most information systems development effort to date has been at the operational data systems level and has focused primarily on student and financial data. Table 1 indicates the percent of resources expended for various data categories for the 48 institutions included in a recent NCHEMS survey (Mann et al. 1975). Other surveys (e.g., Adams, Kel-

Table 1. Computer Resources Expended by Control Type

	% Public	% Private	% Total
Student	41	31	37
Financial	20	27	23
Faculty/Staff	16	17	16
Alumni & Development	5	12	8
Administration of Academic Departments	6	3	5
Planning & Institutional Research	4	4	4
Facilities	3	3	3
Logistical	3	2	2.5
Physical Plant	2	1	1.5
	100	100	100

Source: Mann et al. 1975

logg, and Schroeder 1976) have found similar patterns. The increasing availability of proprietary computer software packages and the sharing of institutionally developed software through organizations such as the College and University System Exchange (CAUSE) has facilitated systems development and utilization of this type.

Although the student and financial data areas have been leading in terms of development share, computer usage generally has increased substantially in colleges and universities over the past ten years. This increase has been due to a number of reasons. One of the primary reasons is the improved cost/benefit relationship of potential computer usage brought about by the declining cost of computer hardware, easier to use computer languages and other computer "software," and the availability of smaller computer systems ("mini" and even "micro" computers) which are feasible for use even in quite small colleges and universities. The second and no less important reason is the increasing demand for information being placed on institutional managers by institutional personnel, state and federal agencies, and other organizations to which institutions are accountable. This increasing demand for data is based on a combination of an increase in the number of reporting relationships, an expanding set of data being requested, and a (generally) increasing number of students and employees for whom more information is desired.

The general effect of these several influences has been the increased use of computer-based information systems, a greater awareness of the importance of information systems, a trend toward centralization of information systems (at least the management of them if not the actual data and computer systems), and an elevation within the organization of the position(s) responsible for the development and use of information systems. As is the case with many other aspects of the overall theme of this monograph, there is little question that these influences have had *some* impact on colleges and universities. The true extent of that impact is largely a matter of speculation, as is the question of whether such impacts will grow in positive directions.

It is possible to note, however, some of the ways in which information systems could become a more effective support to the quantitatively-oriented manager. One of the most obvious is through improvement of the amount and flexibility of management and planning information maintained in such systems. Today it is typically true that when information such as unit costs, enrollment projections, and community needs assessments or program evaluations are required, they must be collected and prepared as a special study or else extracted from the operational system data base through specially prepared

"crossover" or interface programs. These data are seldom then incorporated into a readily accessible data base or linked to other institutional data. Because of changing institutional data formats and coding structures, these interfaces are often not usable from one period to the next and must be rewritten or substantially modified each time a special study is conducted. As new operational data systems are being developed, however, there are signs that management and planning needs are being considered at an earlier stage. Such needs are being incorporated directly into the data system, or the data system is being designed so that the task of converting operational data to a format useful for planning and management is somewhat easier.

Several examples of frequently encountered problem areas and improvements that institutions are making should serve to illustrate this point. Note that a wider acceptance of data codes or coding structures is part of the improvement being made in the specific problem areas. The importance of using common data convention and analytical procedures — where these structures do not compromise an institution's uniqueness — cannot be overemphasized.

History of a student's major — Attrition studies and the development of historical student change-of-major (i.e., transition) data for use in enrollment projection studies typically require identification of the several majors that particular students have declared during their period of enrollment at the institution. The operational data system for most institutions maintains only the currently declared major for a student. Determining all previously declared majors typically requires "reconstruction" of the student's history. If the data are even available, this task then involves using old files that may contain several different formats and coding structures. In most institutions this reconstruction task is of such magnitude that it often dictates that the project not be completed.

If this historical data need is recognized at the time the operational data system is designed, the inclusion of relatively little extra space to record change-of-major data could greatly facilitate enrollment projection or other similar studies.

Attribute codes within the accounting structure — Many special studies and reporting obligations require that institutional accounting data be aggregated in a particular fashion. While the accounting systems of most institutions typically permit aggregation or data summaries based on expenditure object code or institutional cost center, most accounting systems do not incorporate other "mapping" or aggregation codes (such as an identifier describing the programmatic

function served by particular accounts). Most institutions must therefore conduct manual "crossovers" for each special study. Because this is a time-consuming and error-prone task it often becomes the obstacle to participating in or completing a meaningful project.

To overcome this problem, a number of newer acounting systems permit several additional codes to be associated with each account number to facilitate special studies. For example, using these systems permits incorporating the NCHEMS *Program Classification Structure* (Collier 1976) code into this account code and thereby greatly simplifies a cost-study crossover.

Maintenance of additional detail — Most accounting systems have been designed primarily to satisfy the institution's fiduciary responsibilities. Practices geared to this need alone do not always support management and decision-making. For example, the use of a single account to record both income and expenditure transactions satisfies the institution's fiduciary responsibility, but greatly increases the amount of work required to perform other valuable analyses. Recognizing this deficiency, some institutions are modifying their accounting structure as changes are made in operational data systems.

Common data elements — When institutions wish to exchange and compare data, those data are most easily analyzed if they are reported using the same coding structure and the same codes. When codes (e.g., discipline, student program) are developed for a particular institution without regard to available coding conventions, the institution's data must be converted to the "accepted" code structure for the particular exchange or reporting purpose. To an increasing extent, institutions are incorporating accepted codes and coding structures (as suggested by, for example, the NCHEMS *Data Element Dictionary* or the Higher Education General Information Survey) into their information systems. In some cases, these codes are also adopted as the basic institutional codes.

Compatibility of data — An increasingly important focus of planning and management in higher education has been the development of data to help an institution present a better case to funding agencies, accrediting bodies, and other reviewers of the institution's efforts. Development of these data often involves comparisons with similar institutions. Both the institution and other users of these data must be satisfied that all data are compatible (i.e., produced using the same definitions and procedures) if they are to be used for decision-making purposes. The use of common data codes, common costing procedures (see Chapter V) and other widely accepted definitions and procedures

greatly facilitates the development of data sets that are compatible from one institution to another and from one time period to another.

While some institutions have made these kinds of management-inspired changes to their information systems, the majority have yet to give adequate recognition to planning and management needs as information systems are changed or developed. Fortunately, there is a growing awareness that information systems can support more than just student record and accounting needs. Institutions are gradually realizing the importance of involving the ultimate users of systems in all stages of their development (Brady et al. 1975). As these users become more knowledgeable about the potential capabilities of information systems, they should recognize the additional levels of decision-making that can be accommodated by a properly designed information system. The net effect should be an overall strengthening of supports and abilities related to quantitative management approaches.

Cost and Resource Information

The essence of quantitative approaches to higher education management concerns the identification and use of quantitative information. Such information is intended to illuminate the nature and expected consequences of the decision alternatives available to the manager. In its most basic form, the question being addressed is: How can the resources available be best used to produce desired results? Often this question is actually considered in terms of dual concerns described as efficiency and effectiveness: Are we getting as much output as possible per unit of resource consumer? Are we achieving our objectives to the greatest extent possible given the resources available? It is important that the manager address both of these questions. Considering either one without the other leads to ideas like "cheapest is best" or "money is no object" or similar nonsense. Keller (1976) gives an especially clear analysis of the interrelationship of effectiveness and efficiency concerns.

Thus, the quantitatively inclined manager needs to have access to two major bodies of information: resource use or efficiency information and outcomes or effectiveness information. This chapter focuses on the former while the following chapter treats the latter.

Examining and accounting for resource use is obviously not a new phenomenon in higher education. However, traditional "accounting" has been primarily oriented to fulfilling fiduciary responsibility. Have the funds entrusted to higher education been used legally? Were the funds expended for the purposes that the funders intended? College and university accounting systems were designed primarily to satisfy requirements for fiduciary accountability.

The view described above suggests that although fiduciary accounting is important, this aspect of reporting on resources is only half a loaf. It is not enough to know if funds have been used legally and expended to provide salaries, benefits, goods, and services as budgeted. It is also important to know if funds were used efficiently and effectively. This conviction leads beyond a tracing of the funds to an examination of the mix of resources purchased with those funds. A determination must be made as to whether the resulting benefits justify the expenditure or if a different combination of resources might produce increased benefits for the same or less money. It is this broader type of cost analysis that is the concern of this monograph.

Cost-analysis techniques probably date back to the formation of our oldest colleges and universities. The early college president and faculty had to decide what courses of study the institution would offer, how many students might enroll, how many faculty to hire, and which books to purchase for the library. In translating these decisions into a budget, the early college president was, in fact, performing rudimentary types of cost analyses. The primary purpose of the cost analyses was to convince a Board of Trustees that these were the appropriate resources needed to carry out the educational mission of the college. The cost analyses also provided a plan as to how the college's resources would be spent in the coming year. Finally, they established a yardstick by which to measure the college's performance in management throughout the year. Cost analysis can thus be defined as a division, formation, and reformation of cost and related data for some specific purpose. Typically, cost analyses are conducted to impact decisions. Cost analyses, in themselves, do not answer questions; they provide information that may shed light on the problem at hand. Faculty, students, administrators, trustees, and legislators make the decisions. The information produced by cost analyses is only one of the important elements in the management and decision-making process.

In discussing cost analyses in higher education, any one of several frameworks could be adopted, including those based on types of cost information and cost determination techniques. The one we find most useful is a use/decision structure developed by Adams, Hankins, and Schroeder (1975) at the University of Minnesota. In developing their conceptual framework, they focused on the *decision process* and the *potential uses* of the cost information from the viewpoint of the institution. They reviewed the existing literature under four major headings: (1) resource acquisition, (2) resource allocation, (3) resource management and control, and (4) accountability. Their framework is particularly helpful in summarizing the work already accomplished and in highlighting areas where future efforts might prove fruitful. Other comprehensive reviews of the literature that could benefit the reader are contained in Witmer's dissertation (1971) on the economic value of a college degree and the GRADCOST study in which Powel and Lamson (1972) explored the costs and benefits of graduate education. A more recent paper drafted by the NACUBO Costing Standards Committee (1975) provides the reader with a basic knowledge of cost-accounting terminology and techniques used in higher education.

Resource Acquisition

Resource acquisition includes the processes that are involved in de-

termining and securing from various sources the funding needed to carry out the educational programs of the institution. Resource acquisition can be further subdivided into the processes of estimation of current funds requirements, pricing or tuition-setting, and cost recovery. The early college president prepared a budget based on a set of pedagogical assumptions, and every postsecondary institution in the country goes through a similar process. Enrollments are estimated, class-size limits established, faculty hired, books and supplies purchased, and (occasionally) new facilities are built. This entire process of budget preparation requires cost analyses to support it. Cost-analysis techniques vary from simple, back-of-the-envelope calculations to elaborate modeling efforts, and it is worth highlighting some of the major work to date.

One model is the Resource Requirements Prediction Model (RRPM 1.6) developed by NCHEMS (Clark et al. 1973). This model is a generalized, computer-based, instructional cost-simulation model. It is designed to help a manager examine the financial consequences of varying assumptions about student enrollment, program mix, and operating policies. Although this kind of cost projection information is only one element of decisions in this area, it does appear to have utility for managers. For example, in a recent case study (Service and Schoemer 1977), managers at Colorado State University cited the model's role in discharging CSU's reporting responsibilities to the Colorado Commission on Higher Education, executing several steps in the university's annual budget cycle, and generating long-range resource projections as a part of the CSU master plan.

Several planning models are available and have been described in the literature. Judy and Levine (1965) reported on CAMPUS (Comprehensive Analytical Models for Planning in University Systems); Midwest Research Institute (1972) promoted HELP/PLANTRAN (Higher Education Long-range Planning/Planning Translator); Peat, Marwick, Mitchell and Co. (1970) developed SEARCH (System for Evaluating Alternative Resource Commitments in Higher Education); and Massy and Hopkins (1974) developed a Dynamic Equilibrium Model for University Budgeting at Stanford University.

Each of the generalized planning models is limited by the fact that so little is known about cost and revenue behavior in higher education. Cost projections are made to a large extent on the basis of average cost information adjusted for changes in volume and price. No thorough analysis has been conducted examining the fixed, variable, and semivariable components of costs. NACUBO has recently drafted (1976) a paper, as yet unpublished, that establishes a conceptual frame-

work for conducting this type of analysis. If this line of inquiry proves fruitful, the utility of planning models should be substantially enhanced.

A second set of costing activities related to resource acquisition revolves around pricing. All colleges and universities establish tuition and fee rates for their educational services. Criteria for establishing these rates include the cost of the educational service provided, the potential value of the educational benefits produced, and the tuition and fees charged by competing institutions. A recent survey (Council for Postsecondary Education, State of Washington 1976) of state coordinating and governing bodies indicates that in six states, tuition and fee rates are established as a proportion of the operating cost of instruction. The report points out that several other states are considering adoption of similar policies. Such policies dictate the use of cost analyses on annual or biennial bases to provide information for the adjustment of tuition and fees. Many private institutions also relate tuition rates to the cost of instruction, though not necessarily on a strict formula basis. Student tuition and fees account for a larger share of the private institution's operating revenues and thus may make them more sensitive to market conditions than are public institution's tuitions and fees. An enrollment drop of only a few percentage points can have serious ramifications on the private school's budget. Most private institutions charge differential tuition rates among their professional schools, and at least one of these institutions is proposing to extend this policy to their undergraduate programs as well. Policies of this nature assume the operation of fairly sophisticated program-costing methodologies.

Another form of pricing that occurs within the institution is the determination of prices for such items as food services, dormitory accommodations, agricultural products, etc. The pricing function in these instances relies to a large extent upon analyses of historical unit costs resulting from the use of methodologies that attempt to determine "full" or true costs. Because auxiliary enterprises closely resemble profit-making enterprises in their operation, it can be assumed that the price-setting activity for these types of operations are similar to their counterparts off campus. Colleges and universities do not always recover the full costs of auxiliary enterprises through service fees, but choose instead to subsidize a portion of these operations through general funds.

A special adaptation of pricing found in colleges and universities is indirect cost recovery. The concept of indirect costs emerged in the mid-1940s as colleges and universities took on major roles in support

of the national war effort. These indirect cost-recovery procedures were primarily aimed at obtaining some reimbursement to the institutions for those overhead expenditures incurred on behalf of special research and training efforts. Recognizing that these projects placed an additional burden on college and university administration and support, indirect costing procedures were developed and implemented. Today these procedures are embedded in Federal Management Circular 73-8 (the 1973 successor to OMB Circular A-21). Virtually every institution with research grants or contracts with the federal government conducts this specialized form of cost analysis on an annual basis.

Resource Allocation

Resource allocation includes the processes associated with determining which activities within the institution are supported at what levels. Budget requests are typically generated at the departmental level. Each of these individual budget requests is merged into a total budget request for the institution. After a series of budget reviews by academic administrators, by boards of trustees, and, in the case of public institutions, by coordinating councils, governors, and legislatures, the budget is finally approved. At that point, funds available to the institution are allocated to the academic departments and support units. Various types of cost analyses provide information for use as a basis in making these allocations.

The traditional approach to budgeting in higher education focuses on line items and objects of expenditure. Each department head enumerates projected faculty positions by rank and salary level, support staff positions, fringe benefits, instructional supplies, travel, communication services, etc. These projections are typically made by examining last year's budget and making incremental adjustments for changes in salary level, workload, estimated enrollments and student-faculty ratios. In this incremental approach to budgeting, the *status quo* is accepted and only minor modifications are made to the budget each year.

A variation of this approach is the program budget. Through an analytical tool such as RRPM 1.6, a traditional line-item budget is transformed into one that relates resource costs to programmatic outcomes (Clark and Huff 1972). With RRPM, for example, one measure of programmatic outcomes is the amount of instructional service provided for the number of students majoring in a particular program. The program budget gives administrators and trustees a better idea of how the college's resources are being spent. For example, attention is

focused on the number of students studying history and the number of history majors graduating from the institution rather than on the number of history professors being hired. Coupled with information from follow-up studies of graduates, administrators and trustees have the potential to improve their understanding of the effectiveness of their past programmatic decisions.

A more complex budgeting tool — one that has high usage in industry, but is seldom used in higher education — is standard costing. A standard cost is a measure of what an item *should* cost, as contrasted with what it actually costs. Standard costs are calculated by applying pre-determined sets of policy variables to program cost data. For example, based on a specified faculty salary schedule, workload assumptions, and student-faculty ratios, it would be possible to determine that a semester credit of lower division history should cost $122; similarly, upper division history should cost $178 per credit and graduate work $323 per credit. Enrollments could then be projected for the next academic year and the history department's budget be based on the projected enrollments multiplied by the standard costs.

Cost accounting texts cite several advantages (Anthony and Welsch 1974) in using standard cost systems in industrial settings. First, they are an excellent means of controlling costs. Actual costs are periodically compared with the predetermined standard costs and if large differences (variances) occur, adjustments to the production processes are made. Second, standard costs are often used in determining prices. Third, standard costs produce more rational cost information than do actual costing systems because any quirks produced by historical costs would be eliminated. And fourth, a standard cost system once installed and operating is cheaper to maintain than an actual cost system.

Standard cost systems by and large have not been adopted for use by higher education and for very sound reasons. Use of standard costs assumes a thorough knowledge of the educational process and the ability to intervene in that process to vary the resource mix and level. It also assumes the standardization of the product or the service rendered. It is obvious that this is not the case for the classroom or the research lab. This instance provides an excellent example of how the complex and unique nature of higher education places a direct and obvious limitation on a particular quantitative approach to management.

Standard costs are used to some extent to establish prices for goods and services transferred from one unit of an institution to another. Probably the best examples of internal pricing within a university are

found in the academic computing center. Computing services are fairly standardized and their outputs can be expressed in terms of minutes and seconds of processing time. Standard costs can be calculated and the using departments can be charged a predetermined rate. Cost variances can then be examined after the fact to determine whether the computing center is operating at the desired level of efficiency. Standard costing is also applicable to other academic support activities such as libraries, audio/visual services, and physical plant operations and maintenance.

Hoenack and Norman (1974) and Minahan (1974) in separate articles have suggested extending the concept of internal pricing to the entire university. Academic units would operate on a decentralized basis attracting dollars from various clientele groups, i.e., students and research agencies. Each academic unit would determine its own fee structure and would be free to purchase services from central administration or outside vendors. Prices of instructional services would be strongly affected by academic labor markets, student demands, and competing research demands. In essence, the university would operate under a pricing system similar to that which exists in a free market enterprise. In a report (Breneman 1971) of a conference sponsored by the Ford Foundation Research Program the following theoretical shortcomings were noted that would tend to make widespread use of internal pricing infeasible:

> (1) There is no complete and well-defined schedule of college or university output values. This is to say that no legislator, state government, or university administration has, as of yet, successfully constructed a schedule of the relative societal or public values for the various existing types of departmental degree programs or academic curriculum.
> (2) The practice of single-year budgeting in most colleges and universities militates against the possibility of a department adequately developing efficient cost/product programs over the long run.
> (3) The relative inflexibility of academic staffs through the use of collective bargaining contracts and tenure contracting radically impairs an academic department's ability to respond quickly and efficiently to administratively perceived shifts in public education market demands.

Resource Management and Control

Resource management and control include the processes that are intended to monitor expenditures and initiate adjustments in response to changing conditions. An organization will typically implement a management or control policy closely aligned with its planning and budgeting system. Historically, colleges and universities have operated with fiduciary accounting systems. Built around various fund groups,

the fiduciary systems were designed primarily to give assurance to funding agencies that their money had been expended for the purpose for which it had been appropriated. Control features built into the accounting system would be line-item comparisons of actual expenditures to budgeted amounts at various times during the year. If actual expenditures were seriously out of line, a reallocation of funds might be necessary.

Another concept of management control is the responsibility center, a term that denotes any organizational unit that is headed by a manager who is directly responsible for that unit. As applied to colleges and universities, the responsibility centers are the academic departments and administrative units, and the managers are the department heads, deans, and administrators. Each manager is responsible for his or her unit's plans and budgets and is accountable for all expenditures made in that unit. Reports summarizing the budget and expenditure information for the unit are provided to the unit manager on a periodic basis, so that the projected flow of expenditures can be altered if necessary.

A more sophisticated type of management control can be achieved with a standard cost system. As explained in the previous section, standard costs are a measure of what management thinks average costs should be. When standard costs are compared to actual costs, a cost variance emerges. The cost variance is positive or favorable if the budgeted costs exceed the actual costs. Similarly, the cost variance is negative or unfavorable if the budgeted costs are less than the actual costs. In our previous example, the standard cost for lower division history was calculated at $122 per credit. But based on an after-the-fact analysis, the actual cost was $142 per credit. The analysis is then structured to examine each of the resource categories and policy variables used in the determination of the standard cost figure to explain to the manager why the cost of history is higher than it should be. Explanations might be that several senior faculty members taught introductory courses this semester, or that enrollment in several sections was less than predicted, or perhaps two faculty members were on sabbatical this term, which added to the cost of the entire department. The reasons for the cost increases are isolated and then it is the responsibility of the department head and the dean to determine whether these higher costs are reasonable or if corrective action should be taken.

Accountability

Accountability is the principle under which funding sources are ap-

praised as to whether resources are spent for the purchase of goods and services for which they were intended and, secondarily, whether proper value was received for those expenditures. A key trait of accountability is that it generally occurs after the fact. Traditionally the college financial officer met accountability obligations by publishing financial reports that were prepared in prescribed formats (NACUBO 1973), audited under prescribed principles and procedures (AICPA 1973), and became the primary source of financial information for college trustees and alumni. However, with the demand for increased accountability by legislators, students, parents, alumni, and funders, college administrators devised ways to better inform their constituents about how their money was being spent. Program-costing methodologies (Topping 1974), such as those used in NCHEMS Information Exchange Procedures (Gamso and Service 1976) were developed in response to the demand for increased accountability.

A full-costing methodology, such as that used in IEP, takes traditional financial information and classifies it in a program structure (see the chapter entitled "Foundations for Quantitative Information"). Thus, one can easily see how much was spent on instruction, how much on research, how much on academic support, etc. In addition, the costs of support functions, such as plant operations and maintenance, are allocated to final cost objectives to yield full costs. Third, instructional unit costs are displayed both by academic discipline and by student program of study. By assigning costs to programs and by comparing these program costs to perceived outcomes, a rudimentary form of cost-effectiveness analysis can be performed. This exercise may be nothing more than asking oneself if it's worth $13,000 per year to educate a dental student. Refinement of abilities to conduct this kind of analysis is dependent not only on progress in the area of quantitative outcomes information (see Chapter VI), but also upon improved understanding of the basic nature of the educational process and the relationships that characterize it.

Further Research

As should be clear from this review of the development and use of quantitative cost information, most cost-analytic work takes place either at the beginning of the planning process (resource acquisition) through the substantiation of budget requests or at the end of the planning process (accountability) through the justification of use of past resources. Because planning and management activities occur on a cyclical basis, these two operations are often conducted simultaneously, i.e., last year's cost analysis work being performed in col-

leges and universities is aimed at current or potential funders — primarily state legislatures and federal agencies.

The interest in cost analysis for internal management purposes is more recent and therefore not as well focused. Bacchetti (1976), in a paper published in the NACUBO Professional File, outlined the following uses of cost analysis for internal management purposes: trends and comparative analyses in instruction, actuarial analyses, estimating marginal cost-benefit relationships, projecting alternative costs, relationship and tradeoff analyses, and institutional self-education. The planning models mentioned earlier also fall under the heading of internal management. There has been a great deal of discussion concerning these models as well as some instances of successful implementation efforts, but few schools are using the models on an ongoing basis — updating the planning information periodically to reflect recent changes in policy variables or campus environment. Examples of cost-analysis techniques used in management control are even more difficult to find. Perhaps there is so little flexibility in administering colleges and universities that midstream corrections are next to impossible to effect.

There are, however, several areas related to cost analysis and its use in higher education that warrant further investigation:

- *An attempt to relate specific uses of cost information to the decision-making process that occurs in higher education.* The techniques of cost analysis may have outpaced the academic administrator's ability to comprehend and effectively use the cost of information currently available. Perhaps it is time to slow down the technical development of costing methodology and take a closer look at the utilization of the data currently being produced.

- *A reexamination of the planning models currently available to college administrators to see if they can be adapted to the concepts of fixed versus variable costs.* As previously mentioned, most planning models presently are driven by average cost figures. While this may have served educators in a time of rising enrollments, planning and funding models based on average costs will be detrimental to colleges and universities with stable or declining enrollments. Other alternatives to average costing methodologies should be explored.

- *Experiments with differential pricing schemes.* At present, students at the same level are charged a flat tuition rate regardless of the subject matter they are studying (except for some professional fields of study). As it becomes feasible to determine full program costs, funders (students and state legislators) will become more adamant about the

need to implement pricing structures that are more closely related to costs.

- *Further studies in standard cost-accounting systems and internal-pricing schemes to determine the extent of their applicability to colleges and universities.* These management techniques are well-developed in the commercial sector and should be studied more closely for their potential applicability to higher education.
- *Development of resource-allocation models based on goal and outcome-oriented variables.* Currently most resource-allocation models are enrollment-driven, that is, "the more students you attract, the more money you'll get." A matter worth investigating is the attempt to interrelate the resource-allocation process more directly to the stated goals and objectives of the institution.
- *Cost/Benefit Studies.* For years, educators have claimed that no further progress could be made in cost/benefit studies until the benefits of education were measurable. Substantial progress has been made in the identification and measurement of certain kinds of outcome variables. New efforts should now begin to examine how cost and outcome information can be more effectively integrated.

Goals and Outcomes Information

It has been argued previously in this monograph that quantitative approaches to higher education management must strive for some degree of comprehensiveness to be fully effective. Quantitative information and management techniques must deal not only with operating *efficiency* but also with *effectiveness* or results. The generation and use of quantitative outcomes and effectiveness information is an integral part of the approaches described in this monograph.

Recognizing that outcome information is needed does not guarantee that it can be obtained. In fact, it must be acknowledged that progress in outcome assessment lags behind the progress already made in other quantitatively oriented areas. Some movement has been evident (see Lawrence et al. 1970 for a description of some of the beginnings), and there is cause for optimism with respect to current and future progress. However, this optimism must be tempered by the realities associated with using quantitative outcomes information.

Some of these issues are germane to all types of quantitative information and have been alluded to in previous chapters. Other issues are unique to the outcomes area either in degree or form. For example, one of this latter type is the fact that there is as yet no real consensus as to what constitutes an outcome of higher education, either conceptually or operationally. Even the variety of labels used to describe phenomena in the outcomes area suggests a considerable diversity of opinion. Outputs, impacts, effects, benefits, results, products — all these and more describe ideas that fall somewhere in the outcomes neighborhood. Conceptually simple outcomes definitions that derive directly from the input/process/output systems model are simply not adequate. Lenning et al. (1977) provide a comprehensive discussion of these kinds of definitional difficulties and suggest an organizing structure that can potentially overcome some of them.

Operationally, the definitional problem is as large or larger. In practice, individual context and perspective play a large part in determining a working definition of an outcome. An outcome viewed from one perspective may or may not be considered as an outcome when regarded from another perspective or placed in another context. For example, most colleges consider their graduates to be outcomes of the educational process. However, the employers who engage these graduates are more likely to consider them as inputs to the labor

market. Similarly, newly arriving students might usually be thought of as inputs except from the perspective of the admissions office, whose programs and activities are geared to produce the outcome of newly enrolled students. Other examples abound.

A related issue is the importance or value attached to specific outcomes, which often varies from setting to setting and from individual to individual. Even if it can be agreed that a particular phenomenon clearly represents an outcome, the question of whether or not that outcome is desirable remains. This is in direct contrast to the situation in other areas. For example, once cost measurement techniques are defined, it can be agreed that — *all other things being equal* — a less costly item is more desirable than a more costly one. In the outcomes area, by contrast, a determination of what constitutes goodness must be explicitly established through some priority-setting exercise. Are more graduates in a particular field a desirable outcome or not? Will a particular program have a positive or negative impact on the community? The essential point for those interested in quantitative approaches is that the description and measurement of outcomes through quantitative techniques is only part of the task. Setting priorities concerning those outcomes is a separate and distinct issue.

Educational outcomes themselves also add to complexity in this arena. Most outcomes occur over extended periods of time and have a complex series of causes and intermediate effects associated with them. The question of joint outcomes (i.e., multiple outcomes produced by a single program and/or a single outcome that results from multiple programmatic efforts) also adds to the need to be cautious in claiming too much for outcomes information.

Perhaps the most visible limitations concern the issue of quantification itself. Many higher education outcomes are simply not susceptible to description in quantitative terms. This is partly true because of the current limitations of quantitative measurement technology. Some of this may change as the field develops; however, there is a high likelihood that many of the results of the educational process are simply to complex ever to be reduced to quantitative terms. Thus, no matter how much progress is made in the measurement area, it will be important to bear in mind that many significant educational outcomes will be described only in qualitative or narrative form and not in quantitative or numerical fashion.

This last point, that some portions of the educational outcomes sphere cannot be quantified, merits reinforcement. It seems to be a characteristic of human nature that quantitatively describing part of a system often leads to a kind of competitive advantage over the part of

the system that is depicted only qualitatively. Kenneth Boulding (1966), for example, noted that when part of a hierarchy of goals is quantified, "the quality and apparent objectivity of quantitatively measurable subordinate goals can easily lead to failure to bear in mind that they are subordinate" (p. 165). Since the overage provided by quantitative information in the outcomes area will always be essentially incomplete, managers and analysts using this kind of information do well to present accompanying qualitative information that can serve to reduce, if not eliminate, the kind of distortion described here.

One particular aspect of this bias toward the quantified part of systems is the observation that inherently subjective (i.e., opinion-based) information often tends to be viewed as objective (i.e., factual) simply because it is quantified. This can obviously be seriously misleading. Opinions are opinions whether quantified or not, and subjective information remains subjective even if it is put in numerical form. Thus, the number of graduates from a particular institution is a *quantitative* statement of an *objective* fact, while the statement that one institution is older than another is a *qualitative* statement of an *objective* piece of data. The observation that Outcome A is more important to the institution than Outcome B is a *qualitative* statement of a piece of *subjective* information. Assigning Outcome A the priority rating of 85 out of 100 and Outcome B a priority rating of 55 out of 100 is a *quantitative* statement of the same piece of *subjective* information. The point here is that both objective and subjective data can be quantified. The process of quantification does not change the inherent nature of either type. The distinction is a critical one and imposes important limitations upon quantitative information that should be kept in mind when such information is used to support higher education management.

All of this implies that quantitative approaches related to outcomes must be made with particular caution and care. The information and techniques developed and applied need to be extremely flexible and adaptable so that they can be tailored to the particular definitions, context, and priorities that characterize individual situations. Although much more remains to be done, some progress has been made. It is convenient to divide this progress into three major areas: identifying and establishing goals, quantifying goals and objectives, and assessing actual outcomes or effectiveness.

Establishing Goals

Effectiveness is a measure of the extent to which desired results are achieved given the resources available. To assess effectiveness it is first

necessary to make explicit what is desirable, i.e., to define the goals of the institution and/or its subunits. The need to delineate and communicate an organization's goals has long been underscored by various organizational theorists (e.g., March and Simon 1958; Selznick 1957; Etzioni 1964; Perrow 1970). Perrow noted:

> Organizations are tools; system, product, and derived goals shape the form of the tool, indicating for what it can or cannot be used. An organization with weakly held goals is a poor tool for accomplishing ends, so that it may be shaped by opportunistic forces in the environment. Thus, goals represent a positive resource for organizations (p. 173).

In his essay on university goals, Conrad (1974) notes that goals: (1) are standards against which to judge success, (2) provide a source of legitimacy to justify the activities of an organization, (3) define organizational needs and priorities, (4) define production units for "outputs" for the organization, (5) define the organization's clientele, and (6) define the nature of the relationship between the organization and society. He also points out that in most universities ". . . goals are often implicit, residing in an extended body of collective understandings rather than in explicit statements." He goes on to say, "If university goals are to serve the purposes listed above, they must be identified more precisely."

Goals of individual colleges and universities have traditionally been described in broad, vague, and often internally inconsistent terms. This did not cause major problems as long as people fully accepted the intrinsic value of a college education and as long as the demands made on higher education institutions remained relatively stable. However, during the fifties and sixties, these institutions came under increasingly severe pressure to grow in size and complexity (pressure readily acceded to by many officials) and to meet the diverse needs, desires, and expectations of many new groups throughout society. In response to these voluminous and diverse demands, institutions often found themselves trying to become "everything to everybody." In the process, colleges and universities of all types grew increasingly alike; they often lost their individual identities as they pursued an ideal typified by the university model. As a result, the unique goals, objectives, and priorities of particular institutions and programs became obscured and could only be dimly perceived by students, faculty, administrators, and external constituents.

This chain of events often led to less than desirable results. For example, Sterling McMurin, former U.S. Commissioner of Education, pointed out in 1974 that:

> Individual institutions have too often failed to develop a clear sense of purpose and enunciate institutional goals which define that purpose. They have failed to concentrate their distinctive characters and capabilities. . . . This situation is now so acute that whereas formerly we simply had a bankrupt educational philosophy, we are now faced with the prospects of numerous bankrupt colleges, colleges whose financial distress is sometimes apparently due at least partly to their failure to expend their resources wisely because they are not clear about what they are trying to achieve and therefore cannot effectively order their priorities (pp. 5-6).

To cope with these kinds of situations and challenges, institutions of higher learning are striving more and more to delineate goals that state clearly: (1) what the institution is trying to accomplish; (2) whom it is trying to serve; (3) how it intends to accomplish its objectives; and (4) the levels of achievement it intends to reach. Without answers to these questions an institution cannot really specify its purposes and goals clearly enough to meet internal needs for direction. Further, it becomes difficult to stake a claim to a place unique within the larger educational community. The more specific, tangible, and concrete the answers to these questions, the more likely it is that institutional goals can become a meaningful direction and communications device.

A needed first step toward such concreteness and specificity — and ultimately toward quantitative description of intended outcomes — is the identification of a limited number of goals that serve to define the broad and vague mission statements that are the rule in postsecondary institutions. This step of narrowing down the possible institutional thrusts or directions to a manageable size has historically been the focus of much work in this area. A number of procedures and instruments have been developed to aid in the process of selecting the goals of an institution from a longer list of possible goals. These include: the Gross and Grambsch (1968) Survey of Educational Goals, Educational Testing Service's *Institutional Goals Inventory* (Peterson 1973), the NCHEMS Inventory of Higher Education Outcome Variables and Measures (Micek and Wallhaus), and *Higher Education Outcome Measures Identification Study* (Micek and Arney 1974). Although some institutions have "started from scratch" by developing their own list from which to narrow down, and others have decided on more specific goals by starting with no concrete list at all, experience suggests that starting with such a tested list will save time and help prevent problems during this step in the goal-setting process. Most institutions will want to modify the particular instrument used by adding additional goals appropriate for that institution or modifying some aspect of a particular goal. Usually, however, the majority

of possible goals for an institution are included, and the goals listed provide a good model for the needed specificity and wording.

Various approaches and processes are used to implement these procedures and actually to establish university goals. Perhaps the most common is the "top-down" approach, in which top-level managers decide on the goals for the institution and then pass them down to other levels of the institution. An alternative is the "bottom-up" approach, such as that being developed at the University of Michigan. In this mode, the lower levels of the institution formulate institutional goals that are passed up and aggregated and analyzed at the top level in the institution, where a final determination is made. The third approach, "up-down," has been developed and implemented at Colorado State University under the direction of Dr. Charles Neidt to define goals for different administrative levels within the institution. Three pools of goals are developed: a department goal pool, a school or division goal pool, and an institution goal pool. The process begins with the faculty and proceeds upward through various levels. Eventually, top-level decision-makers at the institution agree on a set of five goals from the institution goal pool that should be established for the coming year. Once this upward goal selection process is completed the process then reverses itself, so that each school or division can reassess its high-priority goals in light of institutionwide goals, and each department can reasses its goals in light of the established institutionwide and school-level goals.

Various approaches are also available for seeking consensus about institutional priorities, i.e., the relative importance of different institutional goals. Among the more well known techniques are the Delphi method (Judd 1972) and the Q-sort technique (Stephenson 1953). In each case, the objective is to translate various individual preferences into some set of collective preferences that can be expressed in terms of a rating scale or some similar measure.

Evans (1975), for example, reports the use of a modified version of the Delphi method at Portland State University. Respondents to a questionnaire are asked to separate goals into four categories: high, medium, low, zero. The results of the survey are summarized and returned to the respondents along with another copy of the survey instrument. After the survey is completed and the results analyzed a second time, an institutionwide committee decides on the goals to be adopted and the priority of each. In addition to needs-assessment information and the results of the Delphi surveys, decisions about priorities are based on criteria such as: (1) the extent to which an outcome can be achieved; (2) whether or not it lends itself to the method-

ologies and programs of the institution; (3) how much potential the outcome has for leading to postgraduate outcomes for individuals and to community or societal outcomes; (4) the expense and effort that will be necessary to achieve the outcome; and (5) whether or not the outcome will contribute to the institution and maintain its uniqueness with respect to neighbor institutions.

In many respects, establishing goals is a fundamental first step in the overall quantitative approach to higher education management. Even if these goals do not take quantitative form (and typically they do not), they still represent the foundation upon which any judgments about effectiveness must rest. Establishing explicit priorities among these goals then adds significantly to the potential for making useful effectiveness judgments, quantitative and otherwise. The remaining crucial need is to translate quantitative goals into quantitative, measurable objectives.

Quantifying Goals and Objectives

Translating goals into measurable objectives to be pursued by the institution is the step that gives concrete and specific expression to the institution's purposes. It is also a step that is especially difficult to achieve. We are essentially talking about quantifying intended or desired outcomes. Thus all of the issues and complexities described earlier in this chapter come into play. Quantification is undeniably a limited tool in this area but it is an important tool. Inability to state institutional objectives in specific, measurable terms often hinders, if not precludes, assessing the extent to which goals have been achieved. Lack of specificity also increases the difficulty of effective communication with both internal and external constituencies. This is especially true with respect to external constituencies from whom pressures for institutional accountability arise.

In translating institutional goals into measurable objectives, a major difficulty is identifying the outcome measures (i.e., the pieces of evidence) that demonstrate progress toward the achievement of the established goals. One factor contributing to this difficulty is that the persons responsible for identifying outcome measures most often "start from scratch." Furthermore, as in the goal-definition process, there is often difficulty in reaching agreement on specific measures because of the variety of interests, perspectives, and expectations.

In an attempt to help planners and managers overcome this problem, three approaches to quantifying goals have been developed by NCHEMS. The first approach follows a deductive process and utilizes the NCHEMS Inventory of Higher Education Outcome Variables and

Measures (Micek and Wallhaus 1973) as a stimuli for identifying the outcome measures that best demonstrate progress toward a goal. The inventory consists of a list of higher education outcome variables, similar to outcome goal statements (e.g., Vocational Preparation — student ability to seek, gain, and maintain employment). For each outcome variable in the inventory a list of potential outcome measures is presented. For example, two of the potential measures suggested for the outcome variable "Vocational Preparation" are: (1) the number and percentage of graduates desiring to obtain jobs who are employed by a certain date after graduation, and (2) the average first salary of graduates who have obtained jobs.

The procedure suggested for using the inventory to translate goals into measurable objectives involves four steps. First, a particular goal is linked to one or more of the outcome variables in the inventory. Second, measures that will provide the most appropriate indicators of goal achievement are selected from the list of potential measures. Third, a particular level of performance or criterion is established for each measure selected. Finally, each selected measure with the established level of performance is written into a "measurable objective" statement.

A second approach, also deductive in nature, is based on a survey questionnaire that contains a set of goal areas and potential "measures of progress" for each goal (Romney 1976). The questionnaire allows the various respondents to indicate: (1) the appropriateness of each goal area for their institution and (2) the appropriateness of each measure as evidence of progress toward achievement in that goal area. It should be noted that in the initial version of the "Measures of Progress" questionnaire, the goal areas were based on those listed in the *Institutional Goals Inventory* developed at the Educational Testing Service (Peterson 1973). Many of the suggested measures of progress listed for each goal area came from the NCHEMS Inventory of Higher Education Outcome Variables and Measures.

The third approach to help quantify goals represents a modification of the *Higher Education Outcome Measures Identification Study* (Micek and Arney 1974) procedures. Unlike the two approaches described above, this approach follows an inductive process. The basic procedure is to administer the "Outcome Measures Identification Study" questionnaire to a predetermined group of respondents. The respondents are asked to indicate the extent to which a particular measure, drawn from a large pool given in the questionnaire, reflects the actual outcomes of the institution. Based on the responses to the questionnaire, an assessment can be made concerning which outcome

measures were endorsed by all the decision-maker groups involved and which were unique to certain groups. Once this is done, the goals of the institution can be inferred from the list of "high priority" measures. As with other approaches, there are disadvantages to this tactic. However, one major advantage that should not be overlooked is that it does not require the respondents to link potential outcome measures directly to established goals. Rather it allows the respondents to identify outcome measures that reflect both *unintended* and *intended* outcomes. The net result of applying any of the three procedures suggested here is a set of quantitative outcome measures that reflects the goals of the institution to the greatest extent possible. Issues of completeness, measurement, and the like still remain. However, there is evidence of real progress in support for qualification of goals and objectives. Integrating such progress with the remainder of the management process must still be considered.

Assessing Outcomes and Effectiveness

Establishing goals and translating them into measurable objectives are central to the planning and management process. At some point, however, managers at different levels must ask themselves: "Did we achieve our objectives?" "Why did we achieve them?" "Why not?" This line of questioning is likely to arise in the context of decisions related to program planning and development, resource allocation, program management, as well as in relation to the reporting of program outcomes (both intended and unintended) to various external publics (e.g., funders, accrediting groups, parents).

Although most managers recognize a need for better understanding of the outcomes of their programs, they are quick to point out the problems involved. First, as noted above, the specific intended outcomes (objectives) of programs are difficult to identify and agree upon since the interests and values of individuals and institutions differ. Second, even when intended outcomes or objectives are identified and some consensus is reached, few explicit criterion measures or indicators of program effectiveness can be obtained because of a paucity of adequate data collection instruments. Finally, in cases where information about the outcomes of programs has been obtained, major difficulty is encountered in interpreting and using the information. Such difficulty can be attributed to a range of factors: the complexity of the educational process, the multiple and joint outcomes of programs, the lack of adequate data analysis techniques, and the scarcity of sufficient data bases for interprogram and interinstitutional comparisons. These myriad problems are very real and must not be

ignored. However, they have not entirely deterred progress to date in assessing outcomes and measuring effectiveness.

One major area of progress has been the development of some useful models or frameworks for thinking about assessing outcomes and effectiveness and using the resulting information for internal and external reporting. For example, Stake (1967) has highlighted the need to recognize that there are two basic parts to any institutional or program evaluation process — description and judgment. According to Stake, processing descriptive information involves finding congruencies between intended and actual resources and activities. (This process helps answer the question: "Did we accomplish our objectives?") The second step involves determining the linkages between the intended and actual resources, activities, and outcomes associated with an institution or a program. (This second process helps answer the questions: "Why did we — or did we not — achieve our objectives?")

The key to processing judgmental information is classifying it as either "absolute" or "relative." This aspect of Stake's framework is, in his opinion, central to the purpose of evaluation, since ultimately every institution or program is judged in terms of some absolute standard of performance or some relative standard (e.g., another institution or program).

Another model useful for thinking about outcomes assessment and its utility to decision makers is that developed by Stufflebeam (1971). In essence, the model identifies four functions for decision-making: (1) planning, (2) programming, (3) implementing, and (4) recycling. To serve these functions, four evaluation strategies are required: (1) context, (2) input, (3) process, and (4) product. Although quite complex, this model provides a useful framework for understanding: (1) what kinds of information are needed for different decisions, (2) when it needs to be provided in the decision-making process, and (3) how information about intended and actual outcomes can be integrated in that process.

Astin (1974) and Palola and Lehmann (1976), among others, have developed outcome assessment frameworks specific to higher education. The major contribution of Astin's model is in pointing out that in evaluating the different effects (outcomes) of institutions and their programs on students, it is critical to consider and explain relationships between student inputs (e.g., student characteristics and experiences), program focus (e.g., total institution or individual department), and student outcomes.

The PERC (Program Effectiveness and Related Costs) assessment model developed by Palola and Lehmann at Empire State College is

an attempt to provide a comprehensive evaluation system for a college. The PERC framework focuses on one central question: "What kinds of students working with what kinds of faculty in what kinds of learning programs change in what ways at what cost?" (Palola and Lehmann 1976, p. 75). Given this focus, the model itself is organized in terms of the five major elements of this question: (1) outcomes, (2) costs, (3) students, (4) faculty, and (5) learning programs. The model suggests that "chains of evidence" be gathered over an extended period of time so that assessments regarding student growth and added educational value can be made. Consequently, the PERC model presumes a definite institutional commitment to continuous and longitudinal assessment of student outcomes.

Helpful as these models may be, their ultimate utility to managers and decision-makers still rests upon the ability to produce specific pieces of quantitative outcomes information. It is here that limitations of quantitative approaches in the outcomes area come most clearly into focus. The lack of procedures for collecting outcomes data has, quite simply, been a major obstacle.

This is not to say that outcome data collection instruments are not available. In fact, myriad instruments are available. (See for example, *The Mental Measurements Yearbook* (Buros 1972), and *Evaluation of Institutions of Postsecondary Education: An Annotated List of Instruments*, published by the Council on Postsecondary Accreditation, 1975.) Rather, the basic problem has been one of relevance and cost. That is, most ready-made instruments, especially those that are standardized, are viewed as not valid in many circumstances or not affordable in terms of dollars and time.

Several products recently have been developed that are intended to help solve these problems. One such product is the NCHEMS *Outcome Measures and Procedures Manual* (Micek, Service, Lee 1975). The manual defines a wide range of measures of the outcomes of institutions and their programs (e.g., outcome measures related to Student Growth and Development, Development of New Knowledge and Art Forms, and Community Impact). Procedures data related to each measure are also included. A unique aspect of the manual is that it is designed so each measure and the associated data collection procedures can be considered separately. As a result, the manual is a flexible and adaptable aid that allows individual users to choose those outcome data-collection procedures most relevant to their outcome information needs.

Another similarly flexible and adaptable product is the *Higher Education Measurement and Evaluation Kit* developed by Pace (1974)

at UCLA. The kit contains a set of mini-instruments designed to measure student progress and development, and the education, process, and characteristics of the student body. As an added feature, comparative or normative data for some of the measures are included in the kit.

A third recourse that reflects progress in improving the availability of outcome data collection procedures is the NCHEMS *Handbook for Conducting Student Outcomes Studies* (Bower, Renkiewicz 1977). The handbook is designed to support the collection of student outcomes data at five major points in time: (1) entrance into the institution, (2) some intermediate "in progress" point, (3) the time of degree/certificate completion, (4) post-graduation, and (5) following withdrawal from the institution. The handbook contains separate, ready-made instruments that can be used to assess student progress, change, etc. before, during, and after their educational experience at the institution. One important feature of the handbook is that it contains a separate set of instruments for community colleges and another set of instruments for use by baccalaureate degree-granting institutions.

In the area of student achievement measurement tools, both the Educational Testing Service and the American College Testing Program have efforts underway to help institutions measure student academic abilities and achievements. ETS, for example, has recently initiated a new undergraduate assessment program that makes available a set of 48 achievement tests in the areas of general and undergraduate education (ETS 1976).

Although progress has been and is being made in assessing outcomes and effectiveness, there remain many problems and unmet needs. For instance, as higher education institutions seek to translate goals into measurable objectives, they must avoid the dilemma of choosing between what Tumin (1970, p. 4) calls "trivial precision and apparently rich ambiguity." They must strike a balance between these two extremes.

Institutions must also recognize the problems associated with assessing the "value added" to students. Much of the research evidence indicates the institutions differ very little in terms of the amount of impact they have on students after controls for ability, socioeconomic status, and other factors are made. Recently, however, Hartnett and Centra (1976) have found that by studying departmental effects on student achievement, certain differences can be identified. This focus on departments appears to permit judgments about value-added differences that are masked when the total institution is the unit of analysis.

The need for new outcome measures and instruments still remains an issue. This is especially true with respect to better measures and procedures for assessing competencies, research outcomes, community impact, and the outcomes of various institutional "support" programs (e.g., student services). All in all, it is probably fair to say that quantitative approaches in the outcomes area have come a fair distance down a very complex path; and also that such approaches still have a very long way to go.

Models and Model-Building

The first chapter of this report showed that the field of operations research contained within it the seeds of many of the quantitative approaches to higher education management. As originally conceived, the operations research approach relied heavily on the construction and manipulation of formal, explicit, mathematical models. It is not an exaggeration to claim, as Wagner (1969) did, that "model-building is the essence of the operations-research approach" (p. 10). In many ways, mathematical modeling is the most stimulating, complex, and demanding concept in the entire realm of quantitative approaches to decision-making. It is also the most controversial, provoking a full spectrum of reactions and opinions. While unbridled enthusiasm is rare, many echo the cautious optimism of Mason (1976a):

> The use of computer models as a tool for planning, management, and policy making in postsecondary education seems to be reaching the mature young adult state. After about twenty-five years of development, about fifteen years of youthful and energetic experimentation, about five years of increasingly hard knocks, criticism, failure to win, and (we hope) a growing realization of how to live in this old but constantly new world . . . computer modeling shows promise of producing more usable and useful assistance to the managers of higher education (p. vii).

At the other extreme are strident voices such as that of Hoos (1972):

> The fact that professional problem solvers, such as social engineers, operations researchers, and the like, display an increasing propensity to rely on models of their own making as though definitive of real world processes and phenomena must be viewed as a serious development, for herein lies the symptom of the new orthodoxy, deplorable insofar as it may lead to ignoring important, non-quantifiable factors and dangerous in that it may obscure premises with doubtful validity. (p. 128)

Regardless of which position is more nearly correct, it is a matter of record that a wide variety of higher education management and planning decisions have been examined via mathematical models. Schroeder's (1973) survey identifies four major areas of modeling work: simulation of resource allocation, optimization of resource allocation, student planning, and faculty staffing. Individual campuses have also tackled a diverse set of other problems. (See Czajkowski 1973, for example.)

Resource allocation or cost simulation models are designed to project resource effects of changes in student enrollment, class size, and other key variables. Most of these models are characterized by a logic that translates a set of student enrollment projections into a set of projected workloads and then applies policy or historical parameters to project resource implications of the student enrollments used as input. Major differences among the available models are chiefly in areas such as level of detail or aggregation, amount of data required, size of the model, and cost of implementation and use. Four resource simulation models currently appear to be in actual use to some extent:

- CAMPUS (Comprehensive Analytical Methods for Planning in University/College Systems) ; Judy and Levine (1965).
- HELP/PLANTRAN (Higher Education Long-Range Planning/ Planning Translator); McKelvey (1970).
- RRPM (Resource Requirements Prediction Model); Clark et al. (1973) .
- SEARCH (System for Evaluating Alternative Resource Commitments in Higher Education); Keane and Daniel (1970).

Resource allocation optimization models go beyond the simulation approach and actually attempt to specify an optimal or best feasible resource allocation pattern. Practical limitations with respect to specification of objective functions, data collection, and solution algorithms for models of realistic size currently keep such models in the realm of the conceptual rather than the operationally useful. A variety of approaches have been formulated, including goal programming (Schroeder 1974; Walters et al. 1976), dynamic programming (Wagner and Weathersby 1971) , multicriterion optimization (Geoffrion et al. 1971), and linear programming (Fox et al. 1967). Many models of this type are surveyed in McNamara (1971).

Student planning models have been concerned principally with scheduling of students to classes, student flows through institutions, and enrollment projections. Faculty planning models also have focused primarily on the issue of flows, with emphasis on issues such as faculty rank distributions and optimal staffing patterns. Schroeder's (1973) survey provides an excellent introductory overview of these types of modeling efforts.

The question of which decision areas have been subjected to mathematical modeling is only part of the issue. Given a consideration of the responsibilities of higher education management, it is equally important to ask: Why would one want to reduce decision-making

reality to mathematical abstractions? What are the pros and cons of such efforts?

The "why?" part of the question appears at first to have an obvious answer: to assist managers with responsibility for a particular decision to make a better decision. This instinctive answer is at the same time (1) right, (2) naive, and (3) misleading. It is right because this is the proclaimed purpose of most modeling efforts; it is naive because it does not reflect the complex milieu in which mathematical modeling takes place; and it is misleading because the really significant impacts of most modeling efforts are only remotely related to determining the details of the actual decision that is made.

Several modelers have assembled lists of what they view the purposes and strengths of modeling to be. Many of these lists are strikingly similar. Wallhaus (1969) provides a fairly typical example:

1. They may permit feasible and economical experimentation on real-world systems without incurring the costs, risks, and expenditures of time that may be required in actuality.

2. They allow us to formulate, communicate, and discuss hypotheses.

3. They bring about an understanding of the system variables and their relationships.

4. They make it possible to forecast and project for planning and decision-making.

5. They allow control of the time scale. Real-world processes occur over long periods of time. Modeling can allow long-range intervals to be collapsed.

6. They enable us to control and monitor real-world processes (p. 127).

More recently, there has emerged a greater sensitivity to the fine line between the healthy and unhealthy results that can flow from the pursuit of purposes such as these. Said another way, model builders appear to be increasingly aware that many of these purposes are like a coin, one side of which represents a benefit and the other a disservice. The real dilemma stems from the fact that it is not yet clear that modelers can control the flip of the coin to ensure that beneficial tosses are the rule rather than the exception. This point is emphasized by Kirschling (1976) who described a number of these coin tosses in terms of the claims and counterclaims that can be made about modeling. His list is as follows:

Claim	*Counterclaim*
Models force us to admit how little we know.	Models tend to obscure the little we do know.
If nothing else, models are good because they force an explication of assumptions.	In practice, only model results are discussed; assumptions and limitations are forgotten.
Models often highlight unsuspected or dimly perceived effects and interactions.	Unexpected results are often modeling aberrations due to design or computational problems.
A good model is a tool that can be used by all.	A model is a club that can be used to beat into submission those who are ill-equipped to deal with mathematical symbols and computers.
Models allow a large number of alternatives to be examined in a short period of time.	The time it takes to develop most models means that in practice the questions have already been answered before the model is ready.
Models tend to stimulate a more informed debate and evaluation of alternatives.	Models tend to stimulate debate, but on the model or the modelers, not on the alternatives.
Models are designed to forecast clues to what the future may be like unless we undertake corrective actions.	Because of delays and gaps in gathering, processing, and reporting information, we usually only know today where we were two or three (or more) years ago. More time should be spent figuring out where we may be in the future on the basis of where we were several years ago.
Models are impartial; they attach equal weights to all the evidence.	Most models do not distinguish between good, bad, and suspect data. Bad or suspect data will have as much influence on the models as good data.
A good model encourages the decision-maker to ask questions of it.	Most models implicitly encourage the decision-maker to ask only those questions that can be addressed with the aid of the model (1976, pp. 6-8).

Although this list of pros and cons refers specifically to mathematical models, much of its content may be pertinent to quantitative management approaches generally. Formal models, derived from the original vision of operations research, may simply have been on the higher education scene long enough for this kind of critical analysis to crystalize and be articulated. It may well be that a similar pattern will emerge with respect to the broader spectrum of quantitative management approaches. Indeed, some of the evidence presented in

succeeding chapters suggests that this kind of assessment is already underway.

For the moment, it is worthwhile noting that discussion of mathematical models and model-building, both inside and outside of higher education, is moving beyond consideration of purposes and applications. There is a growing body of critical review that collectively reveals a considerable amount of disillusionment on the part of users of models and self-doubt on the part of developers of models. In the modeling arena, the "rose-colored-glasses" period of the 1960s, when unbridled optimism and claims were commonplace, has been replaced by the sometimes strident, sometimes thoughtful, sometimes apologetic 1970s. To appreciate this "age of discontent," it is helpful to look at a sampling of some of the opinions being expressed.

Dresch (1975), for example, takes a rather extreme position. In a review entitled "A Critique of Planning Models for Postsecondary Education" he raised, by innuendo, the specter that one or more of the modeling efforts that he had reviewed may have not just been unjustified or not very well executed, but that they may have almost been "criminal" in nature:

> The demand for the appearance of rationality in an area in which knowledge effectively does not exist induces an entrepreneurial pseudo-scientism of the type described above, the inadequacy of existing knowledge is obfuscated by virtual fakery, e.g., by painting black skin grafts on white rats, and answers are provided which, arbitrary and useless though they may be, confer at least the aura of justification to action (p. 247).

Kenneth Boulding has also expressed deep-seated reservations about computer modeling generally. He has offered the opinion that:

> Computerized and numerical models, especially those with fancy diagrams and print-outs, are almost certain to produce illusions of certainty and may therefore easily lead to bad decisions. A study of computer-induced disasters, from bankruptcies to wars, is much overdue; we do not seem to have techniques for understanding uncertainty in the context of computerized models (1974, p. 8).

C. Jackson Grayson, dean of the School of Business Administration of Southern Methodist University, who for sixteen months served as chairman of President Nixon's Price Commission during Phase II of the Economic Stabilization Program, pointed out that:

> In the most challenging assignment of my life—putting together the Price Commission—I used absolutely none of the management science tools explicity. One might think that in the task of developing an organization

> of six hundred people (mostly professional), creating a program to control prices in a trillion-dollar economy, and making decisions that involve costs, volume, prices, productivity, resource allocations, elasticities, multiple goals, trade-offs, predictions, politics, and risk values, an expert would have found ways to use his familiarity with management science to advantage. I did not (1973, p. 43).

Grayson's remarks prompted a follow-up article by Zeleny (1975), which reads in part:

> In a recent article C. Jackson Grayson, Jr. states that he used absolutely none of the management science tools explicity. Yet, to the question whether he might have done better by using some management science models his answer is no. How does he know?
> That question is the main subject of this note. Can a decision maker do better without science, models, computers, etc.? In other words, can we rely exclusively on experience, intuition, expert judgment, hunch, or genius? The answer is no. Or, more precisely, it all depends on the decision maker, the problem, and the environment (p. 35).

Zeleny eventually focuses on the idea of managerial intuition. He argues that management science models have tended to promote analysis in place of intuition rather than to see analysis as a means to enhancing intuition. He concludes by quoting Drucker (1973) to the effect that:

> Insight, understanding, ranking of priorities, and a "feel" for the complexity of an area is as important as precise, beautifully elegant mathematical models—and in fact usually infinitely more useful and indeed even more "scientific." They reflect the reality of the manager's universe and of his tasks (p. 516).

Most of the critics go on to offer suggestions for improving the viability of models and the model-building enterprise. Dresch (1975), for example, pointed out that modeling progress must depend on and be interwoven with research:

> Alternative approaches should be encouraged, since the long-term utility and productivity of any one approach can be only imperfectly predicted at the outset. Correspondingly, support for development of comprehensive models should not be viewed as excluding support for narrower research on specific facets of the system. It is not clear that the pursuit of a general model will in the end be the most effective means of improving knowledge of the sector. Major advances in our understanding of the post-secondary education system may require significant breakthroughs in particular facets, and these may then lead in fairly direct fashion to more general increases in understanding. In short, all eggs should not be placed in one basket, and all baskets should not be comprehensive planning models (pp. 249-250).

More ideas about the future — not only for models but also for quantitative management approaches generally — will be treated in subsequent chapters. For now, the key point is that substantial discontent with modeling does exist. And no easy solutions are likely to be forthcoming. Nor is the world of higher education or its management likely to become any less complex or dynamic. In short, significant challenge still lies ahead for those who develop, support, and use quantitative approaches to higher education management.

Use and Impacts of Quantitative Approaches

After considering both the context within which quantitative approaches to higher education management operate and the substance of these approaches, it is natural to ask about the extent and consequences of the use of such approaches. In some sense, there is really nothing new about this question. Speaking of the techniques of scientific management, Plourde (1976) observes:

> Considerable disagreement is raging about the applicability of these techniques to higher education administration. The primary issues are not new, and they have long been at the center of the current debate between administrators and faculties about the "proper" role of administrators in higher education (p. 18).

What *is* new is the growing recognition that quantitative approaches are becoming relatively widespread and diverse and that they are evidently here to stay. Improvements in the state of the art, continued resource pressures and limitations, and increased sophistication among higher education planners and managers all point in this direction. In the face of this recognition, evaluations of the use and impacts of such approaches are increasing in number. There are growing demands for more evaluation studies, and the approaches to and findings of these studies are becoming controversial in and of themselves.

In general, attempts to evaluate quantitative management techniques in the context of higher education have met with many of the same difficulties that arise in efforts to evaluate the impact of higher education itself. Emphasis has tended to be on the measurable; in this case, on the numbers and characteristics of *users* of quantitative information and techniques rather than on the *impacts* — the benefits and disadvantages — that accrue as a result of this use. However, by assembling what is known about the use of these techniques and by weighing the findings and observations of supporters, critics, and those who have sought systematically to assess these impacts, it is possible to come to some tentative conclusions.

One such conclusion is that quantitative information and the associated analytic techniques are in fairly widespread use in higher education. Further, there is additional evidence that use of these approaches can be expected to continue to expand in the foreseeable future. For example, a survey of college and university administrators

conducted as part of an evaluation of NCHEMS and its products provides evidence that approximately 50 percent of the institutions of higher education in the United States had used at least one of these products (Heim 1975, p. 13). A national survey of college and university presidents conducted for the Carnegie Council provides further support for this judgment concerning extent of use. Eleven different planning/management techniques were listed in the questionnaire, and presidents were asked to indicate the extent to which the use of each one had changed between 1968 and 1974 (actual) and 1974 to 1980 (expected). Respondents were asked to check "extensive," "some," or "very little." Their responses are summarized in Table 2. As the authors of the study put it: ". . . it appears that, for whatever reason, more and more institutions are using specialized tools for planning, management, and accountability" (Glenny et al. 1976, pp. 62-63). Apparent levels of current use, coupled with the near-universal expectations of still wider use found by Glenny and his associates, appear to justify an assertion that almost all institutions of higher education will be making use of some kind of quantitative tool or technique in the relatively near future.

However, there is nothing in counts of users that illuminates the more fundamental question: Does use of these tools and techniques yield better decisions and more capably managed institutions? As of now there is no definitive answer to this question. No one has developed measures of "decision quality" and then proceeded to evaluate quantitative management approaches on the basis of their impact on such measures. Nevertheless, some less formal assessments of the impacts of these approaches have been provided by users and researchers.

One fairly broad study was conducted by Heim (1975). This work focused on the impact of products developed at the National Center for Higher Education Management Systems (NCHEMS). The purpose of the study was to obtain the perceptions of managers of higher education institutions about the impact of NCHEMS products on the internal operations of the institutions and on the relationship between institutions and state and federal governments. Findings of the study seem to support some important generalizations. It is clear that there have been increased demands over the last few years for institutional administrators to increase their reliance on quantitative data in making decisions (although it is not clear whether these demands have been the cause for, or result of, increased availability of quantitative tools and the management information systems that support them). Regardless of the source of impetus, most institutional administrators felt that the availability of management information and techniques

Table 2. Change in Use of Various Planning or Management Techniques, Actual 1968-1974 and Anticipated 1974-1980 (In Percentages of Responding Institutions)

Planning/Management Techniques	1968-1974			1974-1980		
	Extensive	Some	Very Little	Extensive	Some	Very Little
Management information system (MIS)	26	47	27	55	38	7
Unit-cost studies	22	52	26	55	39	6
WICHE-NCHEMS products	13	36	51	32	46	22
Program-performance audits	11	41	48	21	54	25
Electronic data processing	47	39	14	58	37	5
Faculty workload studies	24	58	18	49	47	4
Program budgeting/management by objectives (MBO)	17	46	37	47	43	10
Simulation techniques	5	26	69	18	48	34
Analysis of institutional goals	36	51	13	63	34	3
Program evaluation	27	57	16	68	30	2
Market survey, needs analysis	13	49	38	48	43	9

Note: Numbers on which percentages are based range from 947 to 1,166.

Source: Glenny et al. (1976)

was beneficial. The majority of the administrators who had used such tools reported the primary use to be that of learning more about the institution, of providing new ideas and stimulating management thought and, in summary, providing general background information that helped administrators make decisions with greater confidence. At the same time, focused use of these tools in the resolution of specific problems such as "reducing costs" and "making long-range projections" was much more limited.

Tentative findings concerning impacts on institutional relationships with state and federal governments were also reported. Many institutional managers felt that the development of management information systems and related techniques has led to increased requirements for reporting of data to state agencies — data that have had little effect on the credibility of institutions' requests for funds. At the same time, use of these tools has apparently had a favorable effect on the credibility of higher education efforts to improve its management. Over

all, relatively few users sensed that such use had reduced the autonomy of their institutions and had contributed to tensions between institutions and either state or federal governments.

Other, more limited, studies of the uses and impacts of quantitative management approaches are also available. Plourde (1976), for example, focused on four of the best known models for cost simulation (CAMPUS, HELP/PLANTRAN, RRPM, and SEARCH). The purpose of his study was:

> . . . to identify the reasons for selecting an analytical model, the problems and successes of implementation, and the user's perceptions of the usefulness of the chosen model, as well as their views on the use of models for planning and decision making in higher education (p. 21).

Several of Plourde's results are of interest here. Of the 105 respondents to the question of the extent to which initial objectives in using the model were satisfied, 32.4 percent felt that all or a considerable number of objectives were satisfied. With respect to the issue of the extent to which administrative decisions are based on the results of modeling, 15.1 percent replied "often" and another 57.5 percent replied "sometimes." Table 3 summarizes the extent to which respondents felt more useful information to be available as a result of using the model. Plourde observes:

> The indication that models are more useful for long-range planning than for day-to-day management coincides with the respondents' view that the single most important objective was increased forecasting ability (p. 27).

All in all,

> the respondents showed a generally high degree of optimism about the potential of modeling to contribute to institutional management in contrast with substantially more pessimism about the utilization of the modeling systems in their institutions (p. 28).

Table 3. More Useful Information Provided by Model

	Day-to-Day Management (N-186)	Long-Range Planning
None	14.0%	9.1%
Some	29.0	21.0
Much more	10.2	19.9
Extensive amount	5.4	8.1
No response	41.4	41.9

Source: Plourde (1976)

From a different perspective, Bowen and Glenny (1976) report in their study of state budgeting practices that:

> Much more than in the past, the new style of administration will make use of routinely collected, quantitative information. Within the higher education community, decisions will continue to be based on the informed academic judgment rather than on numerical indices, but indices will be available and can direct attention to possible problem areas. . . . Yet information may create as many problems as it resolves (pp. 68-69).

The latter conclusion is based on the cost of acquiring information, the fact that use of resources for data collection and analysis will compete with the resource needs of instruction and research programs, and the possibility that data will be misused by state fiscal agencies.

In a commentary Cheit (1975) also addresses questions about the impact of new management tools and processes. In attempting to answer the question of whether work on management systems has produced better management and planning on campus he concludes that:

> Management systems tend to have some short-term, though limited, benefit; they promise greater future benefit, but it will take several years to test that promise (p. 160).

He also observes that even successful use will not serve to improve public attitudes toward higher education and that the proliferation of management systems is creating a need for academic leaders who are capable of using the results and influencing the design of these kinds of tools and techniques.

In summary, one can only conclude that the matter of impact of quantitative approaches to higher education management is still an open question. There are tentative indications that their use does result in somewhat better planning and management of institutions. At the same time, there are indications that increased reliance on quantitative approaches will result in additional (and potentially costly) data collection and the possibility of increasingly centralized decision-making.

In any event, the development of more and better management science tools for higher education is probably not cause for either extreme pessimism or extreme optimism. They are, at best, aids to (not replacements for) the decision-making processes that have evolved in higher education over the course of many years. Their net effect will be determined by the wisdom and sensitivity with which they are used. Some of the issues associated with this matter of implementation and use are considered next.

Factors Influencing Use of Quantitative Approaches

It has been recognized throughout this monograph that higher education is a complex and dynamic process, that decision-making in that environment has many unique attributes, and that quantitative approaches to higher education management must necessarily be tailored and shaped in a variety of ways if they are to be effective. Many of the specific implications of these phenomena have already been discussed. One final issue that needs to be treated is the matter of how these characteristics interact in practice. What factors appear to have a positive or supportive influence on the use of quantitative approaches? What factors appear to inhibit the adoption and use of such approaches? In short, what practical realities are most likely to separate successful or effective use from marginal use or rejection?

Weathersby (1976) offers a useful starting point for this discussion. Speaking of key legislators and members of governing boards, he postulates five different sources of information that appear to affect policy decisions. He lists, in order of impact or importance: personal experience, information from constituents, organized pressure groups, the media, and (finally!) policy analysis or research conducted by academic institutions or separate research organizations (1976, pp. 100-103). While one may take issue with some elements of this list or its ordering, the overall message is clear. Formal, systematic information takes a back seat to large bodies of informal, anecdotal, and circumstantial information. The situation of the typical institutional manager appears directly analogous. Quantitative and systematic information of the sort that has been in focus throughout this monograph thus faces an uphill battle for that manager's attention! Stated more positively, this recognition reinforces the need for those advocating quantitative approaches to understand this subordinate role in the overall management and decision-making process. Quantitative information cannot and should not replace any of these other sources or types of information — experience, intuition, judgment, and plain old gut-level feeling. Recognizing this reality would seem to enhance the likelihood that quantitative approaches can play an effective role and should not be dismissed as naive, threatening, or irrelevant. Indeed, there are those who believe that early attempts to "oversell" quantitative approaches did not heed this reality and have contributed

directly to increased resistance and negative reactions to such approaches (Mason 1976b).

Brown and Luedeke (1975) take a somewhat different emphasis and suggest that:

> Extension of management information systems in higher education will proceed no more rapidly than the will to manage develops within these institutions. . . . Of what possible utility is a management information system without a management—a designated and organized group of people who are willing and able to manage. Yet, and this is not based on any survey, management information systems have encountered an institutional climate on campuses unsympathetic to the practice of management. This seems particularly true at the upper tier of operating line officers such as presidents, vice-presidents, deans, and the like (p. 573).

They go on to identify several reasons for this inhospitality to management, including (perhaps especially) quantitatively-oriented management. Among the factors they cite are:

> . . . an authentic tradition of amateurism, a tradition which hallows a dean, a president, or a provost who arises from faculty ranks, whose expertise lies in an academic discipline, and who is expected to return to faculty ranks after some period of administrative service.
>
> . . . the connotation of collegiality (which) assumes that professional expertise in teaching and research in an academic discipline automatically extends to the profession of decision making on the campus.
>
> . . . the judgment that institutions of higher learning are comparatively simple institutions (Brown and Luedeke 1975, pp. 574-5).

Their purpose — and ours here — is not to label these characteristics as good or bad in themselves, but only to note that such factors appear unlikely to encourage management–like behavior or increase receptivity to quantitative management approaches.

The same authors point to a number of behavioral factors that may also lower the perceived value of quantitative information and techniques among higher education managers. They observe that although such approaches may provide valuable support for:

> the exploration and definition of alternative courses of action within as broad a spectrum as possible . . . managers are people, and many people do not want to undertake the risks of making decisions among multiple alternatives (p. 576).

Illumination of constraints and identification of new alternatives may only increase ambiguity and perceived risks. In a similar vein, information may:

> illumine undesirable as well as desirable consequences among alternative courses of action. . . . Rarely, if ever, does a course of action have positive benefits for all goals (p. 577).

Making tradeoffs explicit and providing an enhanced basis for accountability may not meet with enthusiasm among all concerned. Finally, there is the possibility that management information systems and related techniques may be welcomed for the wrong reasons and thereby ultimately foredoomed. Brown and Luedeke (1975) write:

> Many organizations wish to be absolutely up to date and to possess the symbols of ultra-contemporaneity. Large, complex computers, with many flashing lights and bells, have long been such a symbol. MIS may replace the number cruncher as the latest status symbol. In an apparently hospitable environment, management information systems might well have all the utility of chromed fins on an automobile. Some will go out and buy an MIS so as to be up to date without bothering to determine how to integrate the system within the institution (p. 578).

Other authors have echoed this last point. Evans (1972), for example, reports that:

> the problem of technical implementation may be a minor one; once accomplished, the human implementation problem—the task of getting the system utilized—may still remain (p. 3).

The work by Plourde (1976) cited earlier is one of the few empirical studies in this area. He examined perceptions of users of four computerized cost-simulation models: CAMPUS, HELP/PLANTRAN, RRPM, and SEARCH. Among other things, respondents were asked to specify and rank the three most important reasons for selecting a particular model. Table 4 summarizes the views of the 124 respondents.

The study was also designed to assess implementation successes and problems. Respondents were asked to rank the three most important factors that contributed to successful or problematic implementation. Responses are summarized in Table 5. Plourde (1976) makes the key point well:

> The importance of organizational involvement is indicated by the fact that 27.7 per cent of the 83 respondents believed organizational commitment at a sufficiently high level to be the most significant success factor. This finding is reinforced by the problem reports: 18.9 per cent of the 106 respondents identified lack of organizational commitment as the principal problem source, and 20.8 per cent identified the unavailability of personnel (which also implies lack of commitment) as the number-one problem.
>
> Relatively few (8.6 percent) of the respondents felt that the model itself was deficient, whereas 24.4 per cent of the respondents considered that the model was the prime reason for success (p. 28).

Table 4. Reasons for Selecting a Specific Planning Model

	Percent of Respondents		
	Rank 1	Rank 2	Rank 3
1. Ease of use on a continuing basis	7.2%	9.8%	6.5%
2. Low acquisition cost	32.0	19.6	15.6
3. Seemingly low operating costs	7.2	4.5	7.4
4. Sophistication of the model	7.2	2.7	9.2
5. Reports output	5.6	8.9	13.0
6. Flexibility of input	3.2	2.7	6.6
7. Promise of external support	1.6	8.0	2.8
8. Availability of external funds	4.0	8.0	9.9
9. Ease of initial implementation	8.0	15.2	7.4
10. Supported by existing computer equipment	4.8	11.6	13.0
11. Key administrators wanted it	8.8	3.6	11.1
12. Other	10.4	5.4	5.5

Source: Plourde 1976, p. 25

Table 5. Factors that Contributed to Success and Problems in Implementation

	Success			Problems		
Rank	1	2	3	1	2	3
1. Cost	13.3%	18.5%	13.2%	4.7%		3.0%
2. The model itself	24.4	17.2	18.4	8.5	11.1	
3. Technical expertise required in-house	14.5	9.9	15.8	8.5	12.1	13.3
4. Organizational commitment at sufficiently high level	27.7	7.5	9.2	18.9	8.1	7.0
5. Commitment to integrate use of the model into the day-to-day decision-making process	6.0	7.5	5.3	9.4	13.1	11.0
6. Use of consultants	2.3	2.5	2.6	1.9	2.1	2.0
7. Education for project staff and key users	4.7	8.6	5.3	7.5	14.1	19.4
8. Availability of personnel to work on project	4.7	13.6	13.2	20.8	22.1	15.3
9. Computer related activities	1.2	11.1	10.5	4.7	12.1	11.0
10. Other	1.2	3.6	6.5	15.1	3.1	11.0

Source: Plourde 1976, p. 27

Finally, a good overview of the complexity of the area under discussion can be obtained through reference to the recent work of Chabotar and Zelan (1976). In the course of developing a design for a study of the impact of selected NCHEMS products, they identified three groups of factors that appear to impinge upon the use and impact of quantitative techniques in higher education management. Although their list is long, it merits careful consideration since this set of hypotheses is a road map to what still remains to be learned. Accordingly, their list of technical, managerial, and social factors is presented here in its entirety.

TECHNICAL

1. *Computer Capability*: A low computer capability for handling the data processing demands of the product is an implementation problem.

2. *Data Base*: An extensive and accessible data base on institutional costs, enrollments, personnel, and other variables facilitates the use of a product.

3. *Divisibility*: A product is more successful in the long-run if its component parts are viewed as divisible, so that it can be implemented on a piecemeal basis. Adopters can use the most "comfortable" parts first before deciding on the rest.

4. *Flexibility*: The organization's ability to tailor a product to fit local conditions is important to its effectiveness for the user.

5. *Gateway Capacity*: If the product is viewed as opening avenues to the adoption of other products, it is implemented more seriously and successfully.

6. *Institutional Research Office*: The presence of a strong institutional research or planning office with operational responsibilities for the product's implementation contributes to its fruitful use.

7. *Product Content*: The harder a product is for users to understand and operate, the less likely its implementation.

8. *Reversibility*: The degree to which and the ease with which the organization believes the *status quo ante* can be reinstated, even after product implementation, has a positive relationship to the organization's willingness to risk implementing the product.

9. *Scientific Status*: A product's technical reputation in the organization as a reliable and valid tool for planning and management will facilitate adoption and implementation.

10. *Stability*: An organization is more likely to invest its resources in a product if it expects that the content and procedures therein will remain relatively stable over time. Continual technical refinements can require greater investments in the product than originally anticipated and thus arouse fear of budgetary problems.

11. *Staff Expertise*: The effective use of a product usually requires a staff with substantial expertise in quantitative methods, research techniques, and management.

MANAGERIAL

12. *Compatibility*: A product's chances for effective implementation often improves if it is perceived as consistent with existing values, past experiences, and current operating procedures and goals.

13. *Cost*: An expensive product's initial and continuing financial cost will be viewed as an impediment to successful utilization.

14. *Decision Making*: The greater the number of decisions made by a small leadership group with little participation from subordinates, the less likely it is that organizational members will work through implementation problems and make good use of a product.

15. *Efficiency*: The extent to which the time and money invested in a product is thought to be justified by resultant benefits contributes to a product's successful implementation.

16. *Expected Long-Term Benefits*: The belief that a product has a high probability of making long-term improvements in planning and management will enhance its success within the user organization.

17. *Expected Short-Term Benefits*: A short-term perspective or an unrealistic expectation of short-term benefits from a product will discourage the user and damage implementation activities.

18. *Financial Resources*: The amount of discretionary funds that an organization has available to invest in a product is positively correlated with successful implementation.

19. *Formalization*: Strict emphasis on rigid rules and procedures in implementing a product hinders its acceptance.

20. *Implementation Process*: If initial and continuing efforts at implementation encounter few technical or administrative snarls, then the user organization will be encouraged to invest further time and money in the product to make it a success.

21. *Initial Positive Results*: A product's implementation is generally reinforced by positive results in the early stages.

22. *Relative Advantages*: The larger the perceived relative advantage the product has over the other alternatives, including current practice, the more likely the product is to be implemented.

23. *Staff Time Available*: The effective use of a product requires that qualified staff have sufficient time to devote to it.

SOCIAL

24. *Change Agent*: Advocacy for a product by a person or office with access to the top management team and credibility throughout the organization is important to its successful implementation.

25. *Commitment by Top Management*: One or more influential members of the top management team must assume a direct and active role in the product's implementation if it is to be successful.

26. *Communicability*: The ease and effectiveness with which the data generated by a product can be understood by organizational decision-makers and external constituencies exerts considerable influence on its implementation.

27. *Communications*: An organization with a significant amount of interaction and communication designed to achieve its objectives is more likely to integrate a product into its operations than an organization with little such communication.

28. *Data Needs*: The extent to which the organization typically values the the use of historical and/or projected data in decision-making is positively correlated with the successful implementation of a product.

29. *Experimental Climate*: A product's chances for success are enhanced to the extent that the organization is willing to experiment with new and possibly untried approaches to planning and management problems.

30. *Point of Origin*: A product is more likely to be implemented successfully if a functionally-related office introduces it to the user organization. (A business office, for example, is more apt to invest in a financially-oriented product than a provost's office with its focus on academic issues and products.)

31. *Pressures for Improvement*: If an organization is under considerable external and internal pressure to improve its planning and management, it is more likely to implement successfully a product designed for this purpose (pp. 23-25).

This extensive set of hypotheses about factors that influence implementation and use of quantitative management products illustrates well the complexity of the processes and issues under consideration. Simplistic responses will clearly not suffice. Realistic appreciation of the difficulties and moderate expectations with respect to continued progress will be much more productive in the long run. In this spirit, we turn in the concluding chapter to a look at some of the needs and challenges that remain to be faced in the future.

The Future

Previous chapters have focused on *progress* to date with respect to development and use of quantitative approaches to higher education management and on the *limitations* that characterize and will continue to characterize such approaches. In conclusion, some of the *challenges* still to be faced will be considered.

The study by Glenny et al. (1976) suggests strongly that quantitative management approaches will be more and more widely applied in the future. Thus, for example, 93 percent of more than 1,100 respondents to the questionnaire forecast "some" or "extensive" change in the use of management information systems during the period 1974-1980. Responses with respect to other quantitatively-oriented management practices were similarly oriented, with only simulation techniques falling below the 75 percent level. In the same vein, Schroeder and Adams (1976) report that "most college administrators want to make use of management science techniques to assist them in operating their organizations" (p. 117).

Kirschling (1976) further suggests that:

> . . . it is important to keep in mind that many, if not most, decision-makers are highly critical of the basis on which they are forced to make decisions. They want better ways devised, and they fully expect that those who are working to this end, such as model builders, will take criticisms constructively and continue their efforts to find better ways (p. 12).

In short, one characteristic of the future is an expectation that the role and capabilities of quantitative approaches to management will expand and mature in the years to come.

This expectation does not deny that many difficult problems remain unsolved or that numerous crucial management needs remain unmet. Indeed, there is no lack of lists — some very long — postulating just which of these problems and needs are the most pressing. Schroeder and Adams (1976), for example, recommend eight specific studies for consideration:

Study	*Objective(s)*
Instruction Outputs	To exhibit high and low instructional output levels by departments and the associated causes.

Tenure Policy	To examine effects of current promotion rates to tenure and possible corrective actions.
Unit Cost Analysis	To develop a system for calculating unit costs of instruction and cost per degree granted and to develop a means of using this data to control costs.
Tuition Policy	To develop relationships between tuition charges and future enrollment levels. Such studies can help predict the effect of raising or lowering tuition on institutional income.
Aggregate Financial Analysis	To examine the structure of budgets and the difference in growth rates between important components of income and expense.
Causes of Student Dropouts	To discover reasons for dropouts and possible courses of corrective action.
Enrollment Projection	To provide a better basis for detailed enrollment projections by major field of study.
Facility Utilization	To examine usage by hours, day, and type of facility and to develop improved scheduling practices (p. 126).

Others offer similar advice. (See, for example, Dresch 1975; and Mason 1976.)

A systematic attempt to define research needs in this and related areas was the focus of a conference sponsored by the National Institute of Education and conducted by NCHEMS late in 1976 (NCHEMS, "Keystone Conference Report," forthcoming). Eighteen different research topics related to management were identified by participants. Their suggestions for future research activities fall into three major categories:

> Understanding managers, managerial incentives, and managerial style
>
> Developing management information and analytic tools
>
> Understanding organizational structures and decision-making processes (p. 24).

Specific topics suggested include many that bear directly on the quantitative approaches we have been discussing. Some of the most relevant are:

> *Comparative effectiveness of open and closed managerial styles*, i.e., which management approaches are likely to be most effective now and in the projected atmosphere of difficulty?

Incentives to manage, i.e., why are people motivated to become managers?

Management response to change, i.e., which management approaches are most likely to deal effectively with responses to unpopular but necessary changes?

Common-core data for management, i.e., is there a minimum set of common-core information that could be collected and kept updated because it is relevant to the resolution of critical, recurring management questions? Who should collect such information? How can it be identified?

Quantification of mission statements, i.e., what are the best approaches to developing statements of institutional mission, role, and scope and how may they be quantified?

Linking short-range budgeting and long-range planning, i.e., how can long-range goals and objectives best be incorporated into a budgeting process that links long-range planning and resource allocation?

Faculty as decision makers, i.e., what are the managerial roles of faculty, including those serving as department heads? Which factors, such as incentives, constraints, and information, influence faculty behavior in managerial roles?

Management functions and configurations, i.e., what are the alternative organizational configurations and what are their implications for management functions and the structures within which they operate? (NCHEMS, forthcoming, pp. 25-33).

Even this abbreviated list (only eight of the thirty-one topics identified at the research agenda conference are mentioned here) illustrates well how much remains to be done.

These formalized lists of unmet research needs should serve to illustrate clearly that quantitative approaches to higher education management are in many respects still in a developmental stage. Significant challenges remain ahead. The existing base needs to be modified and expanded and some entirely new elements need to be added. As a conclusion to this monograph, a few observations about the nature of the challenge seem appropriate.

One idea that comes through strongly is the need for the higher education research and development community to provide conceptual leadership. Direction is required to tailor future advances in a way that compliments education's nature and purposes. If those within the higher educational community, particularly front-line researchers and academics, do not assume the leadership role, there is great likelihood that the void will be filled by individuals less understanding and supportive of education's real mission. The possibilities for distortion and misapplication of quantitative techniques inherent in such an eventuality are real. The challenge of the future is for higher education to provide the necessary leadership within its own community; to use effectively the theoretical and practical resources represented by scholars

in various academic disciplines; and to take an active and progressive position with respect to quantitative approaches rather than a passive or reactionary one, which could ultimately prove self-destructive. One important facet of this challenge is the need to capitalize on the multiple perspectives that characterize different academic disciplines. The disciplines need to be responsive to the overall mission of higher education while continuing to recognize and strengthen their own uniqueness. Producing a synergistic balance in this area is a key element of the leadership challenge before the higher education community.

A second major challenge is the need to focus more on the effectiveness or *end results* of higher education, as opposed to the efficiency methodologies or *means* used to reach those ends. Efficiency must continue to be taken into consideration, but not at the expense of overall effectiveness. A perfectly efficient educational enterprise that fails to fill the roles expected and needed by society could only be termed a failure if not a tragedy. This need for emphasis on end results or outcomes of education is made all the more complicated by the breadth of vision about the proper role and ends of higher education. Gollatscheck et al. (1976), for example, focus on the role of the college as partner and resource to the community. Others see education more in terms of its economic contribution and impacts (Jenny 1976). The perspective of those concerned with state or national planning and coordination of education adds still another dimension of complexity (see, for example, Folger and Orwig 1976; and Halstead 1974.) Regardless of the manner in which debates concerning goals (and hence effectiveness) are resolved, both effectiveness *and* efficiency concerns must be central to the planning and management perspective. The backdrop of larger social concerns relative to equity, justice, and fairness must also play a vital role. The implications for quantitative approaches are clear. Further advances in effectiveness assessment must more than keep pace with progress in quantifying efficiency measures and resource deployment. Unless a balance is achieved and maintained, quantitative approaches will rightly be subject to vigorous criticism and perhaps viewed as part of the problem rather than an aspect of its solution.

Another challenge comes from the very heart of the approaches we have been discussing. Quantification itself is a tool subject to serious limitations. Proponents of quantitative approaches must repeatedly ask themselves: Can these limitations be overcome or are they inherent in the methodology? How can we advance the art of quantification and still maintain the focus on the centrality of human values in

education? We must address the question of whether the "reductionist" orientation that is basic to quantification, or all things reduced to quantitative terms, is in some way fundamentally in conflict with the essential nature of education. For example, quantification and application of the concept of productivity is a particularly thorny problem. Differences in perspective and objectives (e.g., emphasis on the labor market role of education versus the knowledge development and transfer role) as well as measurement limitations seem to raise serious doubts about the operational viability of the concept of productivity in higher education. The need is to think the concept through and ultimately determine whether a workable concept can emerge and what form it should take. In particular, there is a need to define and assess the proper role for quantification as a support to such a workable concept. The real challenge of the future is not to avoid or find ways around such hard questions. Rather, we must face these questions squarely. Answers as such may never be found. But raising the questions will keep some crucial issues in the forefront and force the continuing assessment of both benefits and limitations that must characterize future efforts related to quantification in higher education management.

The last — and perhaps biggest — challenge relates to the ideas with which this monograph began. Higher education is a complex and dynamic social institution. It has had a long and prosperous evolution. More growth and change undoubtedly lie ahead. The challenge for quantitative approaches to management (and, indeed, for management generally) is how to support and enhance rather than inhibit growth, diversity, and change. Previous chapters have outlined many specific needs that must be met if this enhancement is to occur. There are undoubtedly many others. Future work must draw upon a wider and wider base of knowledge and produce an ever-broadening array of approaches and techniques. If quantitative approaches are to make a positive contribution to the continued growth and health of higher education, much remains to be done. Our hope is that those attempting to make progress underestimate neither the importance nor the difficulty of the task ahead.

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